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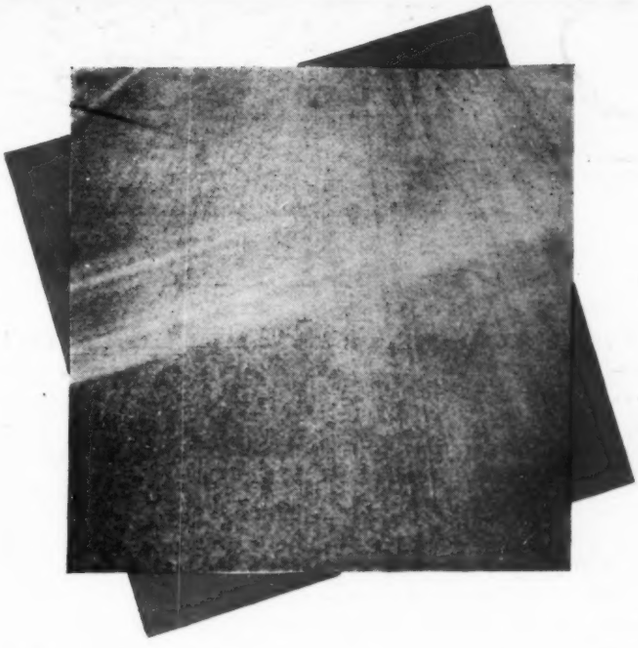

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PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 59 January, 1928 No. 1

Relocating and Building a New Jersey Highway

Eliminating grade crossings, sharp turns and steep grades, and shortening total length by ten per cent. Difficulties in carrying fill across swamp.

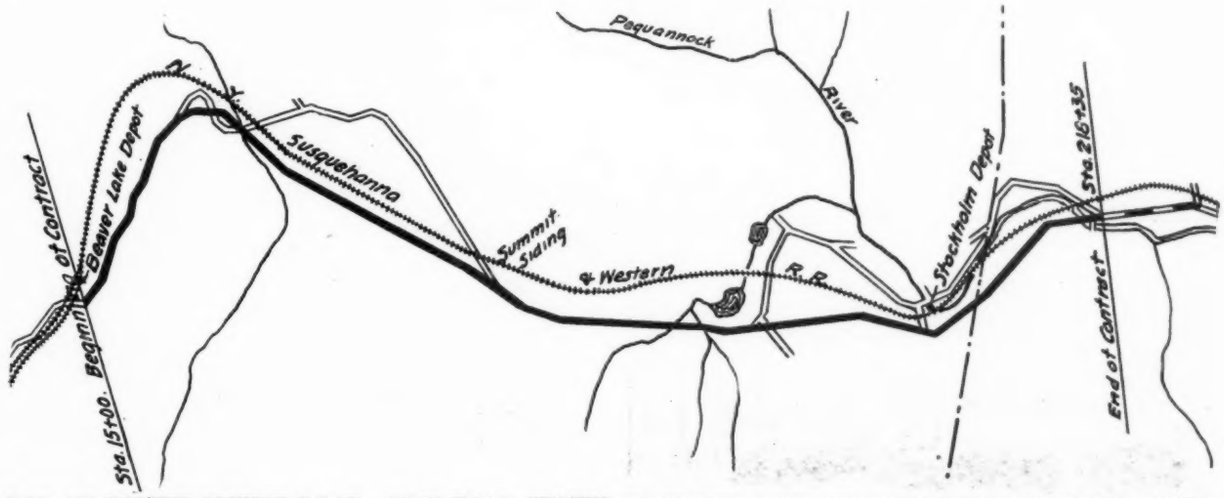
In the relocation and rebuilding of about four miles of road, comprising Section 7, Route 8, of the New Jersey State Highway system (which is also Federal Aid Project No. 85-A), some interesting problems were encountered. Most of these were occasioned by the necessity of adopting a new alignment, partly to eliminate grade crossings. The old road wound in snakelike fashion through the mountains, twice crossing the tracks of the New York, Susquehanna and Western Railroad. Before final acceptance of the new location, comprehensive studies were made over 26 miles of proposed routes, covering six possible combinations of four locations. The route chosen has a length of 3.851 miles, which is half a mile shorter than the old road. The maximum curvature throughout is 10 degrees, and the maximum grade 6 per cent. By the new location, four nearly right-angle turns, one overhead bridge, two grade crossings, and one underpass are eliminated.

The contract, which was let to Winston & Co., Kingston, N. Y., involved 3.851 miles of reinforced concrete pavement, totalling 51,826 square yards; 27,846 cubic yards of earth excavation; 23,455 cubic yards of rock excavation; 26,673 cubic yards of borrow; and the construction of two concrete bridges. The concrete pavement is 8 inches thick, of 1:1¾:3½ mix, and reinforced with 98 to 100 pounds of mesh reinforcement. The width on straightaway sections is 20 feet, and 30 feet on bridges and on curves. The contract price amounted to $399,823.

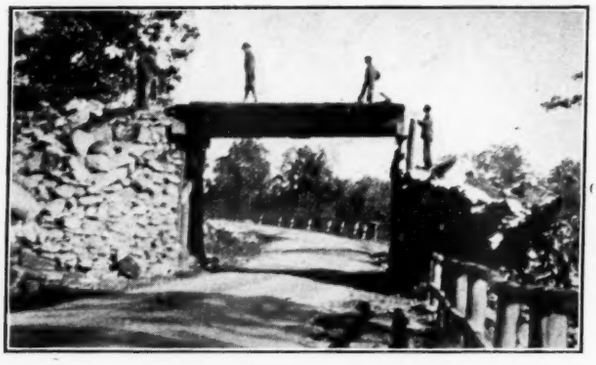
The contract begins at station 15+00, and follows the old road to 43+00, where a steep grade and right-angle turn are replaced with a 6 per cent grade and a 10 degree curve, which was accomplished by making a cut through solid rock. By benching the cut, a minimum sight distance of 300 feet was obtained. This cut-off passes over the old road on a 12-foot fill, and continues over two swamps. In addition to the above curve and grade elimination, the location through the swamps eliminates one overhead and one grade crossing, and a section of dangerous road.

EXCAVATIONS AND FILLS.

Three Erie steam shovels with ¾-yard buckets were used in all excavation and earth handling except fine grading. The shovels loaded into motor trucks, except in places were the hauling was exceedingly rough, where mules and wagons were used. The trucks, which were hired locally, were principally 3 and 5-ton units. Hadfield-Penfield graders were used in leveling fills and in shaping up the roadbed. Two Fordson tractors with bulldozers were employed, mainly in knocking down fills and in maintenance work on the subgrade, shoulders, or other places where a right-of-way was maintained for traf-



MAP OF SUSSEX COUNTY ROAD. NEW ROAD SHOWN BY HEAVY LINE; OLD ROAD BY PARALLEL LINES.



TEMPORARY TRESTLE OVER OLD ROAD AT STA. 48.

fic. Traffic followed the old road where possible, otherwise it was passed over the road under construction.

In rock cuts and in blowing the numerous large boulders found on the new right-of-way, Ingersoll-Rand air compressors and Jackhammers were used. The shovels handled this material very readily, loading into trucks for the most part.

The principal fill was that through the swamp just east of station 43+00. In order to get a direct route to the fill, the contractor constructed a temporary trestle over the old road. This allowed traffic 12-foot headroom and 16 feet width. At the lowest point, the fill was about 6 feet high, while the maximum was about 13 feet. In making the surveys in this section, soundings taken in the swamp showed a fairly compact blue clay overlaid with about 10 feet of muck.

The spoil from the rock cut just west of the swamp was used for the fill, which was started in the winter of 1926-27. When spring came, the fill was not entirely to grade, and while the needed material was being added, the crust of the swamp suddenly broke through, allowing the fill to settle very rapidly, the settlement varying in different sections from 2½ to 6 feet. Some spots required considerable additional material to fill, and filling resulted in displacement of material in another section of the swamp, changing the course of a stream and requiring the relocation of a culvert. Several attempts were made to facilitate drainage of the muck, including dynamiting, but without satisfactory results.

The fill continued to settle, apparently until the clay was reached. In order to expedite the settling, the fill was loaded with a 3-foot layer of earth, which was removed after the fill had become stabilized.

FINE GRADING AND CONCRETING.

A Hadfield-Penfield grader was used to bring the roadbed to approximate grade, after which Heltzel forms were placed, and the fine grading gang brought the surface to the required elevation. Their work was tested by a subgrade tester. The completed subgrade was rolled by an Austin "Pup" roller which operated ahead of the mixer.

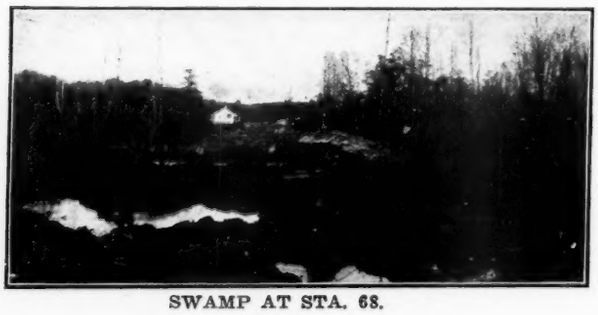
RELOCATION, LOOKING FROM STA. 153.

The coarse aggregate used was the standard concrete gravel regularly used for concrete road work. This material varies in size from about 1 to 2¼ inches. Sand was also shipped in. Phoenix portland cement was used. All material was shipped to Summit siding, and hauled to the job in motor trucks. Mixtures were proportioned at the loading bins, the motor trucks being equipped with batch bodies. Both 2 and 3-batch bodies were used, the former on Packard and the latter on White chasses. The trucks backed up to the mixer, a Ransome 21-E, and discharged the batches, one at a time, into the mixer scoop.

Good time was made by the concreting gang. On September 6, 886 lineal feet, or 1477 square yards were placed; on September 30, 853 feet, or 1421 square yards. On this work, the mixer gang averaged about 15 men, including the operator and foreman, and was made up as follows: 2 men assisting in unloading trucks, charging the scoop, etc.; 6 men spreading and leveling the concrete; 3 men placing steel, setting forms, etc.; 2 men finishing. Truscon Steel Co. mesh reinforcement was used.

One-half the road was placed at a time; and the pouring of the final half was done with the mixer traveling on the completed section. Philip Carey expansion joints were placed at intervals of 30 to 45 feet.

The mixing gang was followed closely by the finisher, who first tamped the concrete with a strike board, and then planed off the surface with a heavy screed formed of 10-inch channel iron weighing 20 pounds per foot. The surface was then tested for regularity, and given a surface treatment with a belt made of burlap covered with bed ticking. The surface was protected with a burlap covering until set enough to permit the use of hay. The hay was kept wet continuously for a period of ten days, when it



SWAMP AT STA. 68.

CUT ON LINE OF NEW LOCATION.

CONSTRUCTION, SHOWING PLACING OF REINFORCEMENT.

was removed. The road was opened to traffic in 14 days.

Water was secured from convenient streams, and distributed through 2-inch pipe laid along the road. Plugged tees were placed at intervals of 400 to 450 feet.

Two bridges are included in the contract. One is a reinforced concrete bridge with a span of 15 feet 6 inches, and the other is a concrete skew bridge with a span of 60 feet 9¾ inches. Culverts are of reinforced concrete or cast iron pipe, the latter being used where the cover is small.

Both colored and white labor were employed on the job. The white labor was boarded at the camp, while the colored labor was provided with sleeping quarters and given credit against their time at the commissary.

The work, which is now complete except for the final details, was under the direction of Chester A. Burn, division engineer, New Jersey State Highway Department, Newark, N. J. J. O. Gustafson is resident engineer, with headquarters at Butler, N. J.

Tandem Maintenance in New Mexico

Tandem maintenance is believed by the New Mexico Highway officials to have proved its superiority over ordinary methods in maintaining gravel and earth roads. It has been adopted exclusively in the Torrance County Training School District and it is probable that it will be adopted throughout the state because of the good results obtained on the road surface, the economy effected in man-power, and the elimination of the ridges of loose material on the roads.

In tandem maintenance, two units of equipment are used in tandem, one following closely behind the other, the two spaced at such an interval that approaching traffic may turn out for the first machine on the right and pass the second on the left. The purpose of this tandem arrangement is to completely cover the road from shoulder to shoulder in one operation, thus giving maintenance to the full width of the roadbed and at the same time cleaning it of any rock, ridges of earth, sand or debris which might furnish a hazard to traffic. The scheme necessarily provides for the casting of the loose material from one shoulder directly across to the opposite shoulder instead of casting from both shoulders toward the center, as is ordinarily done.

This method results in a flat-crown roadbed, which is appreciated by rapidly moving automobiles; it eliminates the ridges of loose earth, rock, sand, etc., that are of necessity left in the center of the roadway when only one machine is in operation, and which may have to remain there several days in case of a breakdown or bad weather before the machine returns.

The equipment for this maintenance may consist of a 5-ton tractor with an 8-foot grader provided with right and left extensions, to be followed by a motor grader equipped with a 12-foot blade, or some standard type of maintainer or drag equipment. It requires the use of two maintenance units on each patrol, where in many instances only one is now in operation, and thus may make necessary a readjustment of patrols, combining some of the shorter ones and in general lengthening all of them. On a 50 to 60 mile patrol it is possible to effect a complete round trip once a week.

Missouri Maintenance Methods

Due to the lack of funds for more desirable power, the Missouri State Highway Department has found it necessary to continue the use of a number of war trucks for pulling graders, maintainers and drags. On certain types of roads, the large trucks are a very satisfactory source of power for maintenance work. Truck patrols in Missouri vary in length from fourteen to twenty miles, depending on the character of the road, topography, soil and traffic condition. Sixteen miles should be the maximum length, but due to lack of funds it was necessary to lay out longer sections. The report of the Department states that where no surfacing exists and soil conditions are unfavorable for the use of trucks, it is necessary to use tractors or teams. Wheel tractors of the 10-20 and 15-30 type are suitable as a source of power for pulling light graders, maintainers and drags. Tractor patrols vary in length from ten to fifteen miles, depending on character of road, soil conditions, topography and the volume of traffic.

Where soil conditions, type and character of surfacing are favorable and traffic is not too great, team patrols are usually more satisfactory than any other type of patrol. Team patrols can be used for a greater variety of purposes, are more reliable; and, in general, better and more thorough results can be accomplished. However, where the soils are heavy or where the character of the surfacing is unfavorable, or where traffic is heavy on earth roads, team patrols are too light. Under such conditions as these, it is advisable to use tractors or trucks in order to obtain more power, although tractors and truck patrol must at times be supplemented with extra teams for certain classes of work. Team patrols vary in length from seven to ten miles on earth roads. The variation in mileage depends upon soil conditions, width of roadway, and the amount of traffic. Team patrols vary from seven to twelve miles on gravel or gravelly soil roads, depending on

the character of surfacing, soil conditions, volume of traffic, and width of roadway.

Rigid type pavements, such as concrete, brick and bituminous, are usually maintained by gang patrols. These patrol lengths vary according to the layout of the roads, type of pavement, and size of the gangs assigned to the sections. Where new pavements have been built recently, it has been found expedient to assign a team patrolman to sections ranging from ten to eighteen miles in length; however, it has been necessary to do considerable work on the shoulders and ditches in these cases. Such procedure is especially necessary on new work where soils are easily erroded and extra labor and teams are expensive or are unobtainable when needed. As soon as shoulders, ditches, and back slopes can be thoroughly seeded and a sod developed, patrols of this type can be dispensed with on paved roads.

Heavy Highway Construction in Davison County, N. D.

By D. L. McLeod*

In the construction of one mile of connecting road, Davison County, N. D., encountered some extremely technical and difficult problems in grading and handling materials. All the work was done by day labor with county equipment under the direction of the county engineer.

Fig. 1 shows the general layout of the work. The width of cut throughout was 60 feet. At (2), there was a 4-foot cut on the south, and a 22-foot fill on the north edge, for a distance of about 600 feet. At (3), was located a 10x10x24-foot box culvert, with full floor and deck reinforcing, which cost $2,383.36. From (3) to (4), two cuts and a fill were required. At (4), 195 feet from the bridge, the ground was 49.5 feet above the water under the bridge at (5), and a considerable cut was necessary. Originally wooden bridges had been located at (3), (5), (7), and (8), but these were washed out many years ago, and in the present work, the stream channel was relocated as shown, eliminating the cost of constructing and maintaining two bridges.

At (7) and (8), where two 30-foot span bridges were eliminated, flood waters had eroded the channel 5 or 6 feet below other parts of the stream bed. In filling the channel it was necessary to dump the dirt as near the holes as possible, and pull it in with a backfiller, crowding the water out. A 15-inch drain was placed under the road, as shown at (8). At (7) the fill was 11 feet, and at (8) it was 18 feet. At (9) there was a steep and difficult side hill, and one-way loading was necessary on about one-half of the cut, as there existed only a narrow way where an old wagon road had previously been. This bank was scaled with a blade grader, until the loaders could be used.

The concrete structures were built in accordance with state plans and specifications. The 30-foot beam span has 30-feet steel piling encased in concrete "U" abutments. It cost $5,269.32. Including 5,500 cu. yds. of additional work on connecting roads, the grading totaled 23,500 cubic yards, and cost $3,651.68. The work was done by day labor, and no cross-sectioning of work for yardage was deemed necessary. The fill was balanced economically with the cut; two borrow pits were required, and the excavation from the new stream channel also was used for fill. By the elimination of the two bridges through the relocation of the stream channel, an estimated sum of $15,305.16 was saved, and cost of bridge maintenance eliminated. It would have been necessary to have a borrow pit equivalent to the yardage obtained from the channel, if the two bridges had been erected.

Prior to 1927, Davison County had no equipment sufficient to do this job. A caterpillar "60" and blade and elevating graders were invaluable on the work. Less than 100 yards were fresnoed; all other excavating was done by the Caterpillar "60," and an Austin elevating grader. On the side hill work, the Caterpillar and an Adams 12-foot blade grader were used to cut steps sufficiently wide for the elevator to work on. Beginning at the top, a plowing would be taken off, and then set back down to a second and third step, until the surface was brought down level to the full width of 60 feet. This was one-way loading. Where one-way loading was necessary long-haul work was done, giving the wagons time to return empty. Stroud 1½-yard wagons were used.

The stream channel was taken out with the same tractor and grader equipment. Mostly it was so soft at the bottom that the wagons could be loaded to only half their capacity without risk of getting stuck or breaking the har-

*County Highway Superintendent.

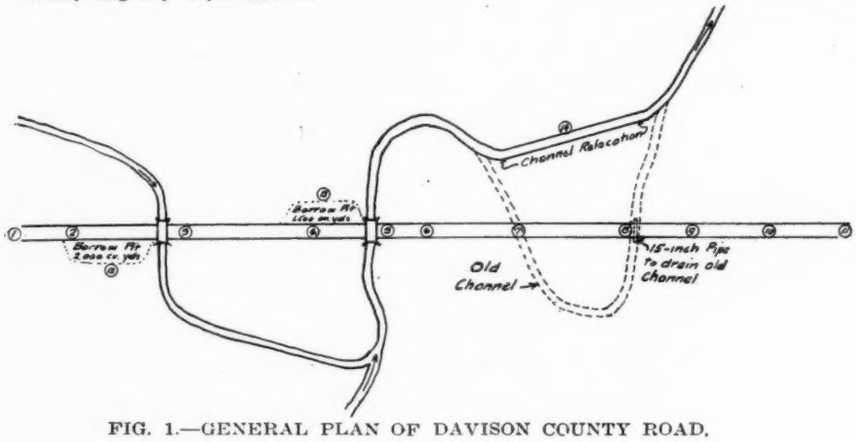


FIG. 1.—GENERAL PLAN OF DAVISON COUNTY ROAD.

FIG. 2.—FILL FOR ROAD AT POINT 2. BUNK CAR AT FOOT OF EMBANKMENT.

ness. The cut was 667 feet long and the teams could get out only at the end.

At (4), in loading up hill only half a load could be handled by the teams; while in loading downhill, the burden on the horses was nearly as great in helping the brakes hold back the load.

A 2-horse Russell highway patrol was used for knocking down the dumps and keeping the grade smooth. The small amount fresnoed was near the channel at (5), and could not be reached with the other machinery.

Riprap was placed at the wings of the bridge. The earth fill was allowed to form a natural slope and this was then riprapped to a height of 6 feet and 20 feet back with "Nigger-head" boulders. At the bottom, some stones weighing a ton were used, these being hauled in a 5-ton Liberty truck with trailer. The riprap cost $300 and the concrete culvert pipe at (8) $112.80, which costs are included in the grading.

This mile of road was of great importance as it lies 11 miles west of one town and 11 miles south of another. While one town would have a better market for some kinds of farm products, the other might be better for other products. Now both markets are available for farmers by gravel roads, excepting for a short stretch, for which the graveling contract has already been let.

FIG. 3.—ROAD BETWEEN POINTS 4 AND 9. NEW CREEK CHANNEL AT 14; OLD CHANNEL AT RIGHT.

The weather was rather unfavorable during the period that work was under way, June 15 to August 20. A wind storm about the end of June blew away the cook car and the accompanying rains washed away the bridge forms. At this time there was water running in both the old and the new channel. In general, it was necessary to work the low ground when possible and the high ground after rains.

The Caterpillar, elevating grader, 9 wagons, 10 teams, and 14 men made up the crew. The work was done under the direction of the writer.

Pile Highway Bridge of Unusual Design

Design and construction of long timber pile bridge across wide, deep channel with soft bottom, to resist strong current and excessive cross stress of tide, waves and wind, with limited appropriation.

By E. D. Jervey*

The design and construction of Breach Inlet bridge in Charleston county, South Carolina, involved, so far as the engineer could find, the use of the timber pile type of bridge in such an adverse combination of depth, strong current, and exposure to wind, tide, and waves as had not heretofore been considered as practicable for this type of structure. Ordinarily bridges of this type are used over streams that are comparatively shallow and in which the gravity loads are the main source of stress rather than lateral loads produced by wind, current, and wave impact. In the case of the Breach Inlet bridge the gravity loads were relatively unimportant, involving nothing more than the employment of the standard type of pile bent bridge; whereas the lateral loads were about as severe as are likely to be encountered. The main problem which the engineer sought to solve was to produce, at a cost not greatly in excess of that of the standard timber bridge, a structure that would be sufficiently strong and rigid to carry ordinary highway traffic and to resist the combined action of wind, waves, and tidal current to which it would be subjected.

*Engineer of Sanitary and Drainage Commission (which has charge of all county bridge and road work) of Charleston County, S. C.

SITE

The site of this bridge is an inlet, about six hundred feet wide and about forty feet deep, at the middle of the channel between Sullivan's Island and the Isle of Palms, two long, narrow islands lying off the coast of South Carolina. Back of the inlet there is a large area of marsh which is penetrated by numerous streams all of which drain through the inlet. This produces in the inlet a tidal current which runs as high as ten miles per hour at frequent intervals and which under storm conditions may greatly exceed this rate. On the seaward side of the inlet there is direct exposure to the open ocean, the only protection being a submerged shoal off the inlet at a distance of about one-half mile. This barrier during storm times would probably be effective in reducing the height of waves, as the fetch between the shoal and the bridge is not great enough to build up waves of maximum height.

TYPE OF STRUCTURE

Funds available for the construction of this bridge were not sufficient to permit the use of steel or concrete, yet it was realized that the conditions were such that the limit would be reached, if not exceeded, for the employment of timber. The pile bent type of bridge with the usual deck appeared to be the only type of structure adapted to the conditions, but this type presented difficulties of a kind that required the closest investigation of the type of bent to be used and its probable lateral stability. Because of the depth of the water, which reached a maximum of forty feet at the middle of the channel, it was necessary to use in the bents unbraced piling for the length of forty feet. The deck of the bridge was placed at an elevation of fourteen, which allowed around twelve feet from the top of the piles to the low water line for bracing. These lengths were fixed by the depth of the water, the requirements for peneration, and the available length of piles procurable at reasonable cost in this locality, that is, about seventy-five feet.

The deck of the bridge presented no great difficulty, since the standard timber deck could be used, except that special provision had to be taken for securing the deck to the bents to resist the lifting action of storm waves under the deck. To provide this, the piles were strapped and drifted to the cap, and all stringers were drifted to the cap and the outside stringers heavily strapped to the cap.

PILE BENTS

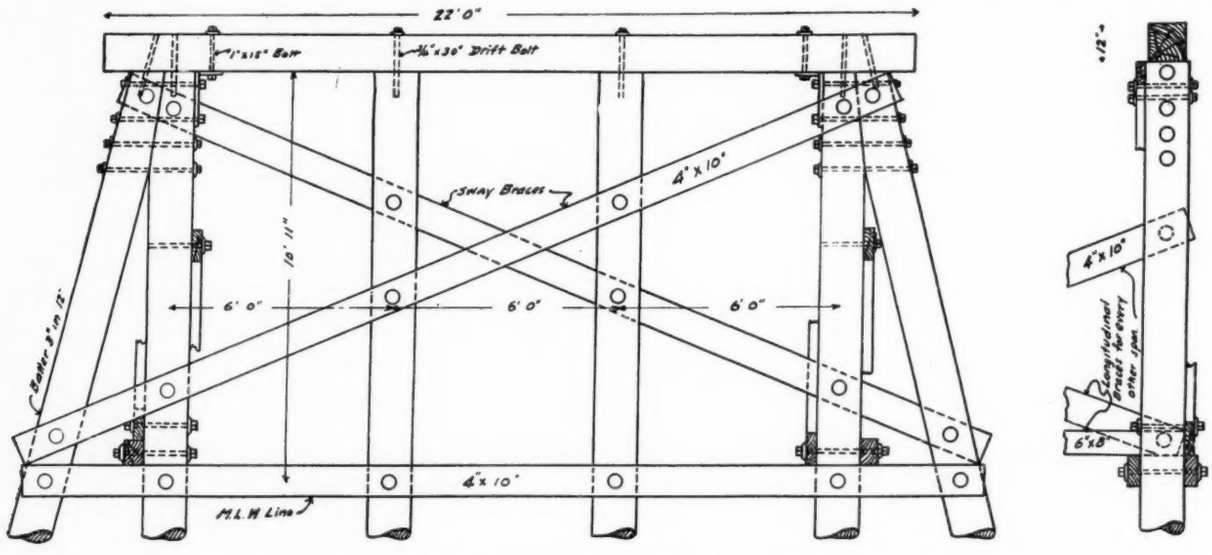
Since the greatest possible rigidity against the lateral loads had to be secured and since the engineer could find little to guide him in estimating the stability of the bents under the prevailing conditions, it was decided to make a series of tests to determine as closely as possible the inherent stability of the different types of bents and to compare the stresses set up in the piles and bracing. Numerous models were constructed to scale, both as to the section moduli and slenderness ratios of the piles and bracing, and lateral loads applied in such a way as to represent as closely as possible both the steady and impact loads on the bridge. The relative strength of the model and the full size bent was estimated, and this relationship was used to predict from the behavior of the models the strength and rigidity of the full-size bents. This method of course is open to serious objections, but no better method appeared feasible, except theoretical calculation as to what could be expected of the bents. In every case an attempt was made to compare the observed behavior of the models with a theoretical prediction of what should have happened.

The loads placed on the models were measured by spring balances and the corresponding deflections by self-registering scales. The intensity and position of the buckling in the individual piles was also noted. After a series of observations had been made on the models, all were tested to destruction, and note made of the points of failure and the nature and intensity of the stresses in the piles and bracing.

The two types of bents that were given closest attention were a six-pile bent with two center plumb piles and two batter piles on each end, each pile being independently connected to the cap; and a six-pile bent with one batter pile on each end securely bolted to the top of the adjacent plumb pile and two plumb piles between. This latter type was finally adopted for use in the deep water at the center of the channel where conditions were severest.

The experiments with the models indicated a decisive superiority of this type over all others tested, both as to strength and lateral stability. In the bent with the four batter piles independently connected to the cap, as would be expected, there was excessive strain thrown on the bracing at the top of the piles, resulting in a distinct tendency to tear the piles from the caps and the bracing from the piles; whereas in the type adopted there was a distinct cantilever action of the connected batter and plumb piles against the lateral loads. As to rigidity, it was noted that the latter type was approximately twice as stable as the former.

In the type of bent adopted it was noted that there was a strong tendency to break the connection between the batter and plumb pile, so great in fact that this joint appeared to be vital to the stability of the bent. Since this joint could easily be made



TYPE D BENT, USED FOR THIRTY-ONE BENTS IN MIDDLE OF CHANNEL.

secure and since it was expected that the contractor would have difficulty in making a flush fit in framing the two piles, it was decided to use four 1¼ in. bolts at this joint to assure a strong connection.

In most of the structures already built, and about which information could be had, it appears that the practice of connecting a batter pile to the adjacent plumb pile in pile bents had not been followed. Where greater lateral stability was desired, the prevailing practice seems to have been to drive additional batter piles and to connect these independently to the cap. However, in nearly all of the cases that came under observation, both in highway and railroad structures, the main loads to be considered were gravity loads, the lateral loads being relatively unimportant; whereas in the Breach Inlet bridge the chief concern of the engineer was to secure his structure against the severest sort of lateral loads, in comparison with which the deck loads were relatively unimportant.

However, the indicated superiority of the connected batter and plumb pile over the free plumb piles was so great that it was believed that it would be a more economical design in most high pile bent structures to employ the former method, particularly in structures where long unbraced lengths of piles must be used. The cost of framing and bolting the piles together is not much greater than that of driving two batter piles, and the added strength and rigidity will in most cases enable the designer to leave out one of the center plumb piles. In the case in question, under about as adverse conditions as are likely to be encountered, the contractor was able to frame and bolt the batter and plumb piles without great difficulty and with first-class results.

BENDING ACTION IN INDIVIDUAL PILES

In the study of the models of the bent, and in the theoretical calculations, it was observed that the bending moment on the batter piles probably would be, under the severest conditions of loading, well in excess of the safe transverse strength of the piles. As has been stated, it was necessary to have from the water line to the mud line an unbraced length of pile of about forty feet, a length which could be considerably increased by the failure of the material at the mud line to give effective lateral support to the pile. It seemed to be the opinion of most authorities that so great a length of unbraced pile, even under favorable conditions as to lateral loads, was unsafe; yet in the case in question there seemed to be no feasible way of reducing this unsupported length.

A study of the models indicated that the bending action in the batter piles opposite to the horizontal loads was due partly to the direct compressive load on the pile and partly to the bending action of the lateral loads acting on the entire bent as a free body. This latter action appeared to increase considerably the bending moment at the mud-line, where, because of the length of the pile, an effective diameter of more than ten inches could not be counted upon.

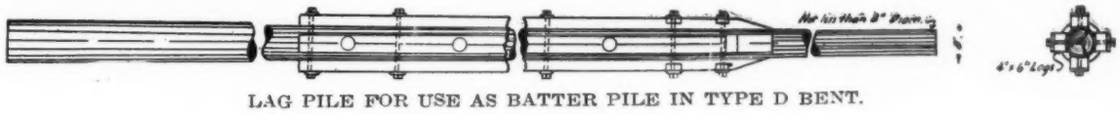
TWO D TYPE BENTS AT RIGHT, ONE C TYPE BENT AT LEFT.

The section modulus of a pile of this diameter appeared to be inadequate for the bending moment. The suggestion that this be relieved by driving two batter piles on a line parallel to the center line of the bridge and a few feet apart, the two to be framed to a plumb pile at the top, was discarded because of apparent difficulty of framing the three piles to each other and to the cap. The alternative of driving two batter and two plumb piles, to be framed together in pairs and to carry a longitudinal cap for supporting the main cap, thus forming a kind of rudimentary pier at the end of the main cap would doubtless have been the most effective means of handling the difficulty, but it added so heavily to the cost of the structure that it had to be abandoned.

LAGGED BATTER PILES

A study of the conditions lead to the conclusion that the deficiency of the weakest section of the piles could be overcome by the use of lagged piles. In this particular use of lagged piles, the engineer could not find any precedent by which to be guided. It was known that lagged piles had been used, but for the purpose of increasing the area for skin friction to supplement inadequate bearing power, rather than to increase the section modulus. Four 4 in. by 6 in. by 24 ft. timbers were bolted to the batter piles in such a position that when driven the lagging would extend about six feet below the mud line and eighteen feet above. The bolts were so placed as to avoid boring bolt holes near each other.

The difficulty of driving the lagged piles was considered, particularly as the bottom of the stream had a high sand content and it was expected that driving would be hard enough to injure the lagging. Provision was made for jetting the piles, but the bottom of the stream did not offer as much resistance as was expected, and no great difficulty was experienced by the contractor in putting the piles down to the required penetration of twenty-five feet. The fact that the river bottom was softer

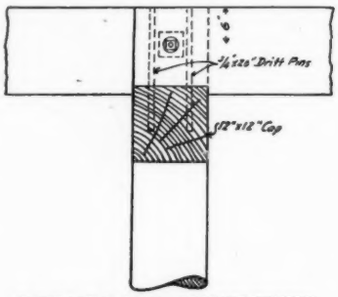


LAG PILE FOR USE AS BATTER PILE IN TYPE D BENT.

than had been expected may result in increasing the actual unsupported length of piling with a consequent increase in the bending moment. While this condition was not considered in the original design, the lagging is so placed as to tend to remedy this condition.

DECK

The deck followed standard practice for timber bridges, except that as already noted, special provision was made for securing the caps to the piles and the stringers to the caps. This provision was considered important in view of the possibility of waves or swells reaching the underside of the deck at high tide. The floor was surfaced with rock asphalt.



DETAILS FOR CONNECTING STRINGERS.

BRACING

Four by ten cross bracing was bolted on to every bent, and also a horizontal brace of the same size was bolted on either side of the bents at low water line. Longitudinal cross bracing of four by tens was used in every other panel, and in the original design six by eight horizontal sash braces were specified to run from the outside plumb piles in every other panel at low water line; however when it was attempted to place these braces it appeared that their effectiveness was doubtful owing to the added area which they exposed to the swiftly running tide, and it was decided to dispense with them. Apparently the longitudinal cross bracing provides adequately for longitudinal stability of the bents.

This construction was used for the thirty-one bents in the deepest water in midchannel. For the next four bents in one direction and five bents in the other there were used three plumb and two batter piles with 3 x 10 cross bracing. For the next six bents in one direction and five bents in the other, four plumb piles with 3 x 10 cross bracing were used; and for the final seven piles in one direction and nine piles in the other, three plumb piles were used without bracing.

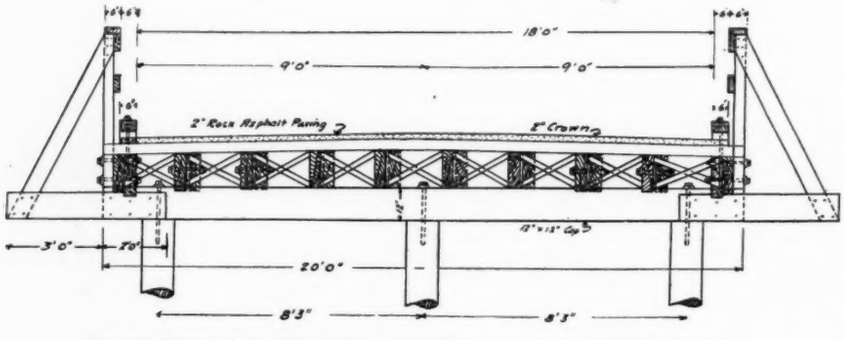
CONSTRUCTION

The chief difficulties encountered in the construction of the bridge were in the spotting and driving of the piles in the heavy six-pile bents in the channel. The depth here was so great (around forty feet) and the flow of the tide so strong, both ebb and flow, that on two occasions piles that had been driven and not lashed were broken off at the mud line by the current.

The smaller bents on the shore and in the shallow edges of the stream offered no difficulties. Work was started on these lighter bents, two skidder drivers being employed, one working from each end of the bridge. A floating driver started at the low water mark on the Sullivan's Island side, but when the heavy six pile bents were reached, it was found that the driving, capping and bracing could be done more effectively by combining the efforts of the floating and one of the skidder drivers. The four plumb piles were driven by the floating rig and securely braced to prevent them being rocked by the tides. Failure to do this on two occasions resulted, as has been noted, in the piles being snapped off. After the plumb piles had been driven, the skidder driver followed the floating rig and drove the batter piles, after which they were cut and framed at the top to the adjacent plumb piles and securely bolted into place. This cutting and fitting at the top of the connected batter and plumb pile was a matter of trial and error, it being impossible because of the varying size of the piles and the variations in the batter to work by any fixed plan.

Considerable difficulty was experienced in spotting the long plumb piles driven with the floating rig. The long submerged ends of the piles were whipped about by the tide, which difficulty was at times increased by the rocking of the driver by the strong sea that was running. There were times when it was necessary to discontinue work until the tide slackened; but by persistent care these piles were placed and driven in remarkably good alignment. In the setting and driving of the brace piles with the skidder driver, especially those that were lagged, even greater difficulty was experienced. Each of these piles was seventy-five feet long and the weight of the lagging and the increased area which it exposed to the tide made spotting and driving a trying job; yet no bad delays or accidents were experienced, and the results obtained were quite satisfactory. All piles were ranged in from the shore, but in the case of the brace piles especial care was given to spotting the points of the piles with reference to the varying depths in order to get the proper batter and to avoid excessive springing of piles to bring them into contact with the plumb piles to which they were to be connected.

The work throughout construction proceeded with dispatch, notwithstanding the adverse conditions, and there were no accidents, serious delays, or failures to comply with the somewhat exacting specifications that governed the construction. The job was finished in less time than was allowed the contractor, and the bridge was opened to traffic on schedule.



CROSS-SECTION, SHOWING TYPICAL DECK CONSTRUCTION.

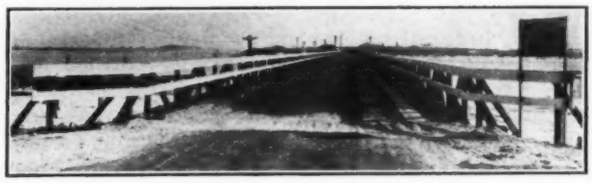
SWAYING OF THE STRUCTURE

Although the bridge has not yet been subjected to anything like the severest lateral loads that may develop, it has been subjected to about as high winds, tides, and wave action as ordinarily occur along the coast except in times of the occasional hurricanes that come up from the West Indies. The behavior of the bridge thus far has been reassuring in that the side sway has been less than was expected for the conditions that have obtained. This swaying is hardly appreciable and to all appearances very much more severe conditions must be realized in order that the swaying may threaten damage to the bents or deck.

In the event that the lateral rigidity of the structure proves inadequate, due to increased depth of water from scouring around the piles and the tidal and wave action to which the bridge is constantly submitted, it may be necessary to resort to an expedient that was considered and rejected at the time that the structure was designed, that is, to sway brace the bents from the lower horizontal brace to the mud line by crossed iron rods, the lower end of each rod to be fastened at the mud line by a chain attached to the end of the rod and dropped around the outside pile in such a way that it will take hold at the bottom when tension is put on the rod, the other end of the rod to be fastened to the outside pile on the opposite side of the bent near the water line, and the rod tightened with a turnbuckle or other means. This plan was rejected as a part of the original design because no satisfactory means could be devised to attach the rod to the intermediate piles under the water line, and it was feared that the swaying of the bent and the slapping of the rods against these piles might set up a sawing action that would seriously injure them. However, if the bridge does not maintain its rigidity this alternative may have to be resorted to.

EFFECT OF MAXIMUM LATERAL LOADS

In the event that maximum conditions of loading are realized, that is, if there is a recurrence of the storms of such severity as this section is not unacquainted with, the stresses to which the bridge will be subjected and its behavior are problematical. The severest test would probably come from a combination of wind and wave action with a tide high enough for the full impact of the waves to come against the deck, bracing, and bents. Just what this would be expressed in terms of pounds per square foot is difficult to estimate. It is certain, however, that the cost of building at this site a timber bridge that could be guaranteed against the worst conditions would have been prohibitive. It appeared to be more economical to design a bridge that would be safe against conditions that ordinarily may be expected to obtain over a period of years, perhaps throughout the economical life of the structure, and to risk the cost of such damage as might be done



ROADWAY OF BRIDGE, SHOWING GUARD RAILS.

by the unexpected, but nevertheless possible, extreme conditions. It is not believed that the worst combinations of loads that may occur would wreck a considerable part of the structure, more than could economically be replaced when the original saving on the structure is considered. All that the engineers can say is that they have done the best that they could with what they had, and if the hurricanes come, the bridge will then have to do the best that it can.

GENERAL

It may be interesting to note that this bridge is at the exact site of the Revolutionary Battle at which Colonel William Thomson (in honor of whom the bridge is to be named the William Thomson Memorial Bridge) on June 28th, 1776, with 600 North and South Carolina regulars, a company of militia and one of Catawba Indians, repulsed 2000 British troops under Sir Henry Clinton supported by an armed flotilla, and prevented them from crossing this inlet to attack Fort Moultrie.

The total cost of the structure was $54,000 or a little less than $53 per lineal foot, which is not greatly in excess of the prevailing cost for ordinary treated pile-bent structures. This structure was of heavily treated material.

This bridge was constructed by the Sanitary and Drainage Commission of Charleston County, which body has charge of all bridge and road work in the county. It consists of Jac. D. Lesemann, chairman; T. Allen Legare, vice-chairman; Patrick Hanley, Frank E. Towles, Wm. Burguson, A. P. Owens and Edward H. Pinckney. A. R. Rhett is secretary.

The actual design and construction of the bridge was under the supervision of E. D. Jervey, engineer of the commission. The bridge was designed by John McCrady of Charleston, S. C.; and J. B. Weston, assistant engineer for the commission, was resident engineer. The Dawson Engineering Company, Charleston, S. C., was the contractor.

Government Investigation of New England Floods

A study of the recent floods in New England was begun while the rivers were yet near their crest stages by engineers of the Geological Survey, Department of the Interior, who already report for some of the rivers higher flood stages than any previously known.

The work on the investigation and resulting re-

BREACH INLET BRIDGE COMPLETED.

port is being pushed by the Geological Survey, and as it progresses advance statements will be given out from time to time, with a final statement when completed. This report will show that the Pemigewasset river at Plymouth, N. H., with a previous maximum high-water stage of 18.17 feet in a record of 41 years, had in this year's flood a peak stage of 28 feet. The Winooski river, with a previous record stage of 13 feet on the crest of the dam at Winooski Gorge, Vt., had in this flood a stage of 27 feet. The flood stage of the Connecticut river at Holyoke, Mass., exceeded that of the flood of 1854, which was 3.1 feet higher than the flood of 1869. It is now believed that this year's flood at Holyoke was higher than any previous flood of which there is knowledge, and it is noteworthy that the records at this locality extend back to 1683.

Frost Boils and Their Elimination

Difficulties experienced and methods used successfully in Minnesota for preventing frost boils by draining road.

By A. C. White*

One of the most baffling duties confronting a highway engineer of the northern states in the spring of each year, is the soothing of the public anger caused by the breaking up, in spots, of non-rigid road surfaces. These spots are commonly called *frost boils*. The highway engineer who is seldom baffled by the large constructive problems often is troubled by the smaller and apparently simple problems. These "boils" attack the road surface in a most vicious manner, and in order to keep traffic moving, the resources of the engineer are likely to be strained to the utmost.

Almost six years ago it occurred to me that it might be possible to eliminate these boils to a very large extent, and a careful study was made of the cause of them. Prior to this we had made several attempts to drain the road-bed by tile laid "herring-bone," installing six-inch tile to a depth of from 3 feet 6 inches to 4 feet 6 inches, and back-filling the trenches with coarse gravel; but these measures were of no avail in seventy-five per cent of the locations.

An investigation of the soil in these places was made when the tile was being installed, and we found that it was practically impervious; and even where the soil was somewhat porous it was not sufficiently so for proper drainage.

In years when there were late rains and extended precipitation throughout the period during which freezing of the ground occurred, the boils were more active in the spring. This led us to believe that there was not sufficient time for the water in the soil to drain out prior to the going down of the frost; the soils leading into these pockets allowed ample sub-drainage, but there was no outlet, and the freezing of the ground when full of water produced a tremendous expansive force, and later contraction caused it to disintegrate.

We also found that after a road had been graded and surfaced, some of the boils had been eliminated and did not reappear at all, or, in some instances, for a number of years. This led to a study resulting in the formation of the following theory.

We are all familiar with the stratification of granular soil during its dry state by vibration. We noted that those road-beds having the heaviest travel suffered most from frost boils, other conditions being equal. This led us to believe that the continual impact of heavy vehicles year after year caused the sub-soils to separate and form different granular stratifications.

It is known that all locations are not chronic producers; in other words, boils do not always form in the same place on the road but from a study, it was found that out of some fifty-five locations, forty-five are chronic, or very nearly so, practically all of them being in cuts.

In 1922, after we had tried different surface materials, such as broken stone, cinders, etc., and after trying tile in every conceivable manner. we started to dig French drains.

In the spring during the eruptive stage of the boils we marked with stakes the ends of each stretch where they appeared. After the road-bed had become fairly stable we broke up the center of the road-bed of each such stretch with a plow and dug a hole with a slip scraper to a depth of thirty inches and a width of four feet. This trench we filled to within eight inches of the surface with one-man size common field stone, placing any smaller stones we could find on top. Gravel was then applied to a depth of twelve to fifteen inches. An outlet was provided with six-inch tile at the lower end of the drain, leading only to the ditch of the road, and this was back-filled with the natural dirt. We made one such installation in 1922, and to date this location—the worst we had in the county—has not erupted once, and no settlement has occurred requiring any renewal of surface material.

In 1926 I persuaded the County Board to place in the budget five thousand dollars in order to make a start upon the total elimination of frost boils on State Aid roads. The result was that approximately twelve hundred lineal feet of boils, involving six locations, were eliminated, at a cost of eighty cents per lineal foot. The gang doing this work was composed of a foreman and five men, with their teams, using a heavy rooter plow, slip, truck and small tools.

In the spring of 1927 we had one of the worst attacks of frost boils we have had for a number of years; but not a single location that had been treated by this method broke up. This so convinced the County Board that this was the proper method of treating these boils, that they allowed me to organize another crew for this year.

Thinking it would be possible to further reduce the cost, we used this year prison labor obtained from those sentenced to the county jail; also, instead of excavating with teams, we blew a trench with Pyrotol. We find that this method works very satisfactorily.

The method used was first to blow a test hole,

*Office Highway Engineer, Mower County, Minn.

drilling the holes thirty inches deep. This gave us an idea of how much explosive to use. The holes were always placed eighteen inches center to center. From one pound to one and one-half pounds were used in each hole. A thirty-hole electric exploder with four hundred feet of insulated wire was used, blowing from four to fifteen holes at once. The debris on the sides was bladed out to the shoulder with a two-horse patrol grader, allowing traffic to continue practically uninterrupted. We were able to blow a trench approximately four feet deep and four feet wide on top.

We were very fortunate this year to have had under way an extensive gravelling program so that it was possible to use as a filler for these holes oversize stones screened from the gravel. We saved a large amount of loading by placing the truck hauling rock directly under the screen. We placed the rock at one end of the trench to be blown prior to excavation, then slipped the rock into the trench with the team, and bladed down the waste bank. We then had trucks hauling gravel to place the surfacing material on top of the rock. This method greatly reduced the cost from that of the method previously used, costing only thirty-five cents per lineal foot, and I believe is as effective.

We have tried one or two slight variations from the above method but will not be able to give the result until after next spring. One variation is the placing of gravel in the trench instead of rock; and another is blowing out one location twelve feet long only eighteen inches deep instead of blowing a deep trench for the reason that it was in the village limits of a small town with dwellings in close proximity to the boil.

We will always have non-rigid surfaces with us, and no matter how well such a road may be graded and drained with deep side ditches, or tile, or both, these boils in time occur; but I believe it is possible to eliminate them by a direct attack along the above lines.

Compacting Highway Fills by Jetting

By Thomas H. Cutler*

Contractors and engineers have found it difficult to construct fills in horizontal layers and to thoroughly compact the fills so that they will be suitable for paving. In recent years, many experiments have been made with water jetting large fills to hasten final settlement. I have used this method for many years in sandy soil, but doubted the efficiency of jetting fills composed of loam, clay, or rocky soil.

On 26 miles of work for which the grading and paving contracts were let at the same time, it was decided to see what could be done by jetting the large fills. All fills 4 ft. and over, except one, on this section of road, were jetted; the fill which was not jetted was 8 ft. in height, and a failure occurred within 2 months after the pavement was laid on this particular fill. There was no sign of failure of the pavement due to settlement on any of the other fills that were jetted, even after a period of more than one year. There was, however, a slight settlement of one 5-ft. fill near a culvert. This fill was only 5 ft. deep for a short distance, and there was probably some negligence on the part of the jetting force. A number of 8-ft. fills and some 20-ft. fills have not settled during the last 2 years. At least, there is no noticeable defect in the concrete pavement that was laid soon aftr the jetting was completed.

Water jetting has so generally proven satisfactory that the Missouri State Highway Department is now using this method extensively. The state highwav department during this last summer made a very careful study of one project in order to secure complete and accurate data regarding settlement of fills that have been jetted, and to ascertain the best methods of jetting. To assist us in making this study, concrete posts were set into the ground to a depth of 3½ feet. at right angles to the centerline, and about 5 ft. outside the limits of the sideslopes. A ½-in. rod in the center of the concrete post provided means for accurately aligning all measurements and distances, and also served as a bench-mark. These markers are permanent and were set deep enough so as not to be affected by frost and they can be used at any time to determine the settlement in the fill or the pavement on the fill. Cross-sections were accurately taken as soon as the fills were completed, and also after rains, before jetting was started. After the fills were jetted, notes were taken each day for a week, and then once a week until the pavement was poured.

The jetting equipment used was an inch pipe with the nozzle end drawn down to a ½-in. hole. The top was fitted with a T-valve, which kept the supply hose from kinking and also provided a means of spraying the road surface without delaying the jetting. Water was pumped as far as 4 miles through a 2-in. pipe with about 160 lbs. pressure at the pump or 60 to 80 lbs. at the nozzle.

Very little effects were noted from rain which fell prior to the jetting, although there occurred three light rains, and one heavy rain during which 7.18 in. of water fell in 40 hours. The jetting was done on 5-ft. centers, the holes being first spudded about 3 ft. deep with a heavy crowbar. The average time to get a hole in an 8-ft. clay fill was about 45 minutes.

After platting the cross-sections taken during a period of three weeks, the department found that very little settlement occurred later than 48 hours after jetting. Several of the fills which showed heavy settlements were checked for sideslope bulging. The settlement was found to be uniform from the shoulder to the toe of the slope; no bulging effect showed in any case. Data were kept and compared for every fill on 7 miles of work with fills varying from 1 ft. to 14 ft. in height. Most of the fills on this job contained rock, sand, and clay; a test on the average sample showing 28 per cent rock, 21 per cent sand, and 51 per cent clay, by weight. The data secured showed 10 per cent settlement for every foot of fill over 4 ft. This percentage

*Engineer of Construction, Missouri State Highway Department.

was also found on hard clay fills. The mealy claps and softer soils showed about 15 per cent shrinkage for fills over 4 ft. At the ends of bridges, culverts and over deep holes where end dumping was necessary, the shrinkage was as high as 25 per cent, but usually about 20 per cent.

We also experimented by surface ponding the fills with water and digging holes at about the same spacing as was done with the jet. The pressure jetting seemed to be more satisfactory. Our cost figures on this work showed 4½ cents per cubic yard as the cost of the jetting, with labor at 50 cents per hour, gasoline and oil for pump at $4 a day, and miscellaneous items at $1.40 a day. This amount does not include the cost or depreciation of the outfit used.

Georgia Bases for Asphalt Wearing Courses

Gravel, chert and other stone, pebble soil and clay-gravel used, wherever found locally.

The practice of the Georgia State Highway Commission in the use of gravel and stone bases for asphalt wearing courses was described by E. N. Seymour, engineer in charge of asphalt work for that commission, in a paper before the Sixth Annual Asphalt Paving Conference. The Georgia Highway Commission has completed 256 miles of various types of asphalt surfaces on gravel base and 214 miles on stone and slag base and has projects under construction totalling 64½ miles on gravel base and 7 miles on stone and slag base. The surfaces placed on gravel bases consist of 202 miles of surface treatment one inch to two inches thick, 58 miles of three-inch bituminous macadam, 14 miles of three-inch bituminous macadam with one-inch sheet asphalt seal, 39 miles of sheet asphalt with binder, 4 miles of three-inch bituminous macadam with one-inch rock asphalt seal, half a mile of rock asphalt and 2½ miles of Topeka mix. On stone and slag bases there are 73 miles of surface treatment 1 to 2 inches thick, 129 miles of three-inch bituminous macadam, 7 miles of three-inch bituminous macadam with one-inch sheet seal, 11 miles of rock asphalt and 1/3 mile of sheet asphalt with binder.

"In the northeast corner of the state there are deposits of chert within hauling distance of the state highways. This material consists of about 25 per cent to 35 per cent binder passing a ten-mesh screen and 65 per cent to 75 per cent hard rock retained on the ten-mesh screen. In the natural state there is a large percentage of material too large to be used in the base so it is all run through a crusher and all material crushed to pass a 1¼ inch screen. This material is crushed at the pit." The supply is limited and "chert base has not been constructed outside of the area composed of about 15 counties in the northeast corner of the state."

The present practice is to construct the base immediately after the grading has been completed, with a width of 19 feet and a thickness of 8-inches. Some base has been used only 6 inches thick, but all future bases will be made 8 inches thick. "The chert base acts as a wearing surface during the period required for settlement of the embankment, or in case funds are not available for a completed pavement it is used until additional funds become available. Before any asphalt surfacing is placed, the base is reshaped and additional material added to give the full 8 inches compacted depth. This method of stage construction gives us a surfaced road immediately after completion of the grading and also insures a completed pavement with true grades and cross section due to the reshaping after settlement. The cost of this type of base varies from about 45c to 90c per square yard, depending upon the distance the material has to be hauled."

In the north central and northeastern sections of the state there are numerous deposits of stone which are available locally for base courses. These consist of limestone, granite, marble, dolomite and trap. Practically all of the stone base is sand-clay bound, and is covered with asphalt wearing surface as soon as completed, as it becomes rough under use. The stone base is generally used as far down into the state as the price for material and the freight rates permit, the cost varying from 90c to 1.10 per square yard. In the central section of the state there are occasional deposits of stone and gravel which can be secured within hauling distance, and the freight rate on slag and gravel from distant points is favorable; for which reason all types of base are constructed in this section.

In the southern part of the state there are deposits of what is termed locally "pebbly soil." The average analysis of this material shows about 35 per cent. to 40 per cent. of metal retained on a ten-mesh screen with a binder composed of well graded sand with clay in the proper proportion. The metal will all pass a one-inch screen. This material has been used as it occurs locally and with the addition of washed gravel to increase the metal content where this runs low. It has given satisfactory results but can be used only where it is found within hauling distance, as the deposits are usually shallow and over comparatively small areas and the cost of hauling for shipment would be prohibitive." With the exception of this and some local deposits of clay gravel, practically all of the base construction for the southern section of the state has been of clay gravel shipped from outside sources. One reason for this is that a great many of the original roads were built of gravel, and in repairing these, part of the original investment is saved by utilizing what gravel remains and adding a sufficient amount to secure the required thickness of base. Reshaping these gravel roads

"is usually accomplished by scarifying, then smoothing with heavy road graders and compacting secured by traffic with almost constant machining. Where the irregularities are comparatively small it is not always necessary to scarify, but the proper surface can be secured with a heavy road grader provided the gravel has sufficient moisture. Where additional material is placed, it is necessary to scarify so that the old and the new material may be bounded together. In any case it is very important that all loose material be thoroughly compacted under traffic before the asphalt surfacing is added."

Clay-gravel, either naturally mixed or artificially mixed from washed gravel and local clay, "has the same advantages enumerated above for the chert base in that it can be utilized as a wearing surface until a more permanent surfacing can be placed and can also be placed immediately after the roadway has been graded and can be reshaped later after the embankment has settled and before the more permanent surfacing is added."

The gravel base is constructed to a compacted depth of 6 to 8 inches and the cost varies from 70c to $1.00 per square yard.

Owing to differences in local conditions, prices, wearing surfaces, etc., it is impossible to compare these various types of foundations as to relative merit, but the commission considers that the results have been satisfactory with all types when all factors are taken into consideration.

Prices on Highway Work in Missouri

The following table, from the 1926 annual report of the Missouri State Highway Commission, shows a comparison of unit prices on contracts awarded during the past six years. The variations in price are of interest, especially the annual reduction in the price of concrete paving during the past four years, during which time most of this type of pavement has been built.

Regional Highway Planning Survey for Cleveland

Field work has been under way since September 3 upon the Cleveland regional highway planning survey, embracing a territory within a radius of approximately 30 miles of Cleveland, Ohio. The survey is being carried on by the United States Bureau of Public Roads and Cuyahoga County as the principal cooperators. Information and assistance is also being rendered by the several administrative organizations responsible for highway development in the Cleveland region.

The preliminary work included a comprehensive study of traffic density—its distribution, origin, and destination—on the various routes in the area. This is being followed by a study of the traffic capacity of the various county highways and the principal entrances into the city of Cleveland and an analysis of the present highway system. Recommendations as to the location of new highway or relocation of present routes will involve consideration of the influence of such factors as topography, waterways, railroad terminals and yards, large industrial plants, suburban developments, and special use areas. With this information there is to be developed a plan of highway improvement adequate for anticipated traffic and designed especially to eliminate highway congestion. An improvement budget for a period sufficient to carry the complete plan into effect will also be prepared.

At the present time collection of field data is practically completed and a detailed analysis of this material is in progress. Traffic records were taken at 263 points in the area and show the daily and hourly volume of passenger cars, motor trucks, and motor

Comparison of Unit Prices on Contracts Awarded for Missouri State Highways

Item.	Unit	High, 1926	Low, 1926	Diff., 1926	Averages 1926	1925	1924	1923	1922	1921
Earth excavation	Cubic yard	$0.80	$0.22	$0.58	$0.36	$0.39	$0.37	$0.42	$0.37	$0.47
Loose rock	Cubic yard	1.00	.31	.69	.65	.62	.75	.77	...	...
Solid rock	Cubic yard	3.00	.916	2.084	1.69	1.69	1.71	1.81	1.85	2.20
Gravel pavement	Cubic yard	4.00	.931	3.069	1.90	2.12	...	...	...	...
Gravel pavement	Square yard	...	...	...	...	.42	.52	.89	.65	.55
*Concrete pavement	Square yard	2.68	1.83	.85	2.228	2.325	2.43	2.66	2.50	2.85
Asphalt pavement	Square yard	1.60	1.20	.40	1.41	1.10	1.18	...	...	...
Pen. macadam pavement	Square yard	...	...	...	...	...	.58	...	...	...
Sledged stone base	Square yard	...	...	...	...	...	1.16	...	...	...
15-inch corrugated iron pipe culvert	Lineal foot	4.00	1.50	2.50	2.28	2.19	2.16	2.28	2.30	2.50
18-inch corrugated iron pipe culvert	Lineal foot	5.00	1.77	3.23	2.69	2.65	2.55	2.58	2.80	3.00
24-inch corrugated iron pipe culvert	Lineal foot	4.50	2.50	2.00	3.70	3.76	3.47	3.36	3.70	3.75
30-inch corrguated iron pipe culvert	Lineal foot	5.00	3.50	1.50	4.45	4.75	4.50	...	4.30	4.50
15-inch V. C. P. culvert	Lineal foot	3.00	1.05	1.95	2.00	1.99	2.12	2.28	2.15	2.00
18-inch V. C. P. culvert	Lineal foot	4.00	1.43	2.57	2.43	2.38	2.53	2.64	2.75	2.50
24-inch V. C. P. culvert	Lineal foot	4.00	2.73	1.27	3.17	3.37	3.21	3.43	3.15	2.75
30-inch V. C. P. culvert	Lineal foot	3.60	3.60	...	3.60	6.25	5.00	4.57	4.75	4.25
15-inch R. C. P. culvert	Lineal foot	6.00	1.75	4.25	2.55	2.48	...	...	...	...
18-inch R. C. P. culvert	Lineal foot	6.00	2.00	4.00	3.05	3.02	...	...	...	...
24-inch R. C. P. culvert	Lineal foot	6.00	3.24	2.76	4.09	4.05	...	...	...	...
30-inch R. C. P. culvert	Lineal foot	6.00	5.00	1.00	5.50	6.80	...	...	...	...
A concrete	Cubic yard	60.00	18.53	41.47	41.82	40.92	30.43	34.60	34.00	44.00
B concrete	Cubic yard	50.00	12.75	37.25	17.22	16.53	18.49	21.90	27.00	29.00
C concrete	Cubic yard	40.00	14.00	26.00	17.27	16.64	17.27	...	27.00	29.00
X concrete	Cubic yard	27.00	12.70	14.30	16.42	15.91	...	...	...	...
Reinforcing steel	Pounds	.10	.043	.057	.055	.055	.058	...	.065	.08
Fabricated steel	Pounds	.12	.045	.075	.065	.065	.076	...	.065	.08
Concrete piles in place	Lineal foot	...	...	...	...	...	4.66	...	...	...
Creosoted piles in place	Lineal foot	2.00	.75	1.25	1.25	1.28	1.70	...	1.35	1.75
Plain rip rap	Square yard	3.00	.99	2.01	1.67	1.51	1.24	...	1.25	1.60
Rolling embankment	Days	40.00	20.00	20.00	25.57	25.34	17.31	...	...	...
Grading	Station	23.75	.60	23.15	6.27	6.37	8.52	...	...	...
Clearing	Acre	110.00	15.00	95.00	51.40	41.03	42.80	...	...	...
Grubing	Acre	142.50	40.00	102.50	80.60	78.53	93.48	...	...	...
Light clearing	Station	107.80	1.00	106.80	10.84	8.85	7.97	...	...	...
Light grubbing	Station	150.00	3.00	147.00	14.79	11.10	10.93	...	...	...

*To the Unit Bid prices has been added the cost of state-furnished materials; the price per sq. yd. represented being thus the total unit cost.

busses on all important highways. Information was also taken as to weights of motor trucks. Records as to the origin and destination were taken for approximately 100,000 vehicles.

The "roughometer" was used in making a condition survey of the improved roads in the area. This instrument is attached to a passenger car and gives an accumulated record of the roughness of the surfaces over which the vehicle is driven.

Another new instrument, used for the first time in this survey, gives a record of the speed at which traffic moves at all points along a highway. This instrument is being used in studying traffic congestion and traffic capacity of various widths of highway.

Water Supply, Sewage Treatment and Refuse Disposal in 1927

Review of progress made in the science and art of each, and notable installations during the past twelve months.

By H. Burdett Cleveland*

WATER SUPPLY

General. A number of changes and advances in water supply and water purification have been developed or emphasized during the past year. The most important change in policy, recently, has occurred in the privately owned water supply field. Several large water works holding corporations, one or two long established but the others newly formed, have been purchasing a network of individual and affiliated water supply systems, principally throughout the east, south and southwest, nearly all of these being purchased from private companies.

This movement represents a step in the opposite direction from the tendency as to ownership and management of water supply systems in this country during most of the past three or four decades, since there had been a gradual decrease in the relative number of privately owned systems through purchase or condemnation of such systems by municipalities and since nearly all newly constructed systems in recent years have been municipal projects. The Public Service Commission of Pennsylvania, in September, refused to approve the financing plans for the purchase of four physically separated water supply systems, privately owned, by a central company on the ground that the approval of the plan would put an obstacle in the way of municipal purchase of privately owned water works, which it is the policy of the state to encourage.

In the municipally owned water supply field a marked increase is apparent in the number of joint water supply districts. Legislation is being enacted or proposed and projects are being carried out in many states for such joint districts. This movement is along the line of cooperation and centralized control and is based on sound economic and engineering principles.

Additional authority is being granted by legislatures to state departments of health in the matter of control of the sanitary quality of public water supplies and a gradual elimination of cross-connections with polluted mill supplies is being brought about. In New York State, for the first time, definite enforceable authority was given during 1927 to the State Commissioner of Health to require that reasonable emergency measures be applied in correcting polluted conditions of public water supplies.

Metering is being given more and more consideration, the outstanding controversy being waged at Chicago as a result of a stipulation by the War Department in connection with the Drainage Canal diversion permit. The use of copper and brass service connections is increasing rapidly.

Completed and Projected Improvements. There was more than usual activity as to number of projects during 1927 in water works construction, both of systems and of filters, and in proposed new projects and additions, although the total value of contracts on water works construction has been somewhat less than the previous year. The November record for water works construction, however, as given by the Engineering News-Record tabulation, shows more activity as represented by value of contracts than during November, 1926.

The most important project for an additional source is the plan of New York City to develop a supply from the Delaware river and its tributaries, brought out by the Board of Water Supply following the failure to date of a tri-state agreement between New York, Pennsylvania and New Jersey. It is proposed, under a twelve-year development program, to obtain a yield of 600 million gallons daily from this source and to obtain under the first two stages of the work a yield of 510 to 540 million gallons daily at an estimated cost of about $270 000,000. This would give, at $75,000,000 less cost, 15 per cent more yield than the plan for development of sources along the east side of the Hudson river as far north as Rensselaer County, proposed in 1926. Under this plan flood flows, only, would be stored, which would improve rather than impair the dry weather flow in the river.

The pioneer bore of the Moffat Tunnel was holed through on February 18, 1927, and the main bore was completed on December 10, this undertaking, as a secondary but important feature, increasing the available water supply for Denver. The tunnel is about 6 miles long and 2900 feet below the crest of the Continental Divide.

A new filtration plant with a daily capacity of 100,000,000 gallons was put in operation in June at

*Consulting Sanitary Engineer, New York City.

Washington, D. C. The old plant was rebuilt as a reserve unit.

At Toronto, a 360-million-gallon daily capacity intake tunnel under Lake Ontario, together with a filter and a new pumping station, are proposed at an estimated cost of about $14,000,000.

At Rochester, N. Y., approval has been given by the city council to a plan for development of Honeoye lake as an additional source of water supply at an initial cost of $12,000,000 and an ultimate cost of $22,000,000, this source having been recommended by a board of consulting engineers in preference to Lake Ontario.

It is proposed to more than double the capacity of the Detroit water filtration plant, completed in 1923.

At New Orleans an addition to the filters, increasing the capacity by 72 million gallons daily, is being completed.

An appropriation of $10,000,000 has been made at Baltimore for water supply extensions.

A second pressure tunnel is to be constructed in New York City from Hill View reservoir to Brooklyn.

Purification. The most important recent developments in purification processes consist in provisions for preliminary mechanical removal of mud and silt from turbid waters before coagulation and filtration, as at Kansas City, Mo., St. Louis, and Lancaster, Pa.; in a wider application of methods for aerating treated waters to reduce tastes and odors and to remove iron; and in a more intensive study of color removal, principally by coagulation with sodium aluminate in combination with the usual coagulating reagent, aluminum sulphate or alum. This latter development in process will apparently, with most waters and especially with highly colored waters, decrease the cost of filtration materially by reducing the amount of alum necessary, the amount saved on the reduced quantity of alum being considerably greater than the cost of the comparatively small dosage of sodium aluminate required.

Other changes in process consist in an increasing adoption of double coagulation, of split or double chlorination, and of chlorination preceding aeration in the case of hydrogen sulphide waters. The use of chloramine, or a mixture of chlorine and ammonia, is being studied at Toronto, and also, as originally, in England as a possible solution of the problem of tastes in chlorinated waters.

Refinement in strainer or underdrain systems for filters, to aid in eliminating washing troubles, is being given close attention.

Considerable advance has been made recently, both in processes and in operation, at water softening plants, principally in devices for handling chemicals and for mixing, in clarification before treatment, in studies of the use of different chemicals and the use of returned sludge, and in recarbonizing lime-softened water.

An increase in the number of filter plant operators' associations and in the number of short courses of instruction covering filter plant operation has been indicative of the increasing interest taken in the efficiency of water filtration plants.

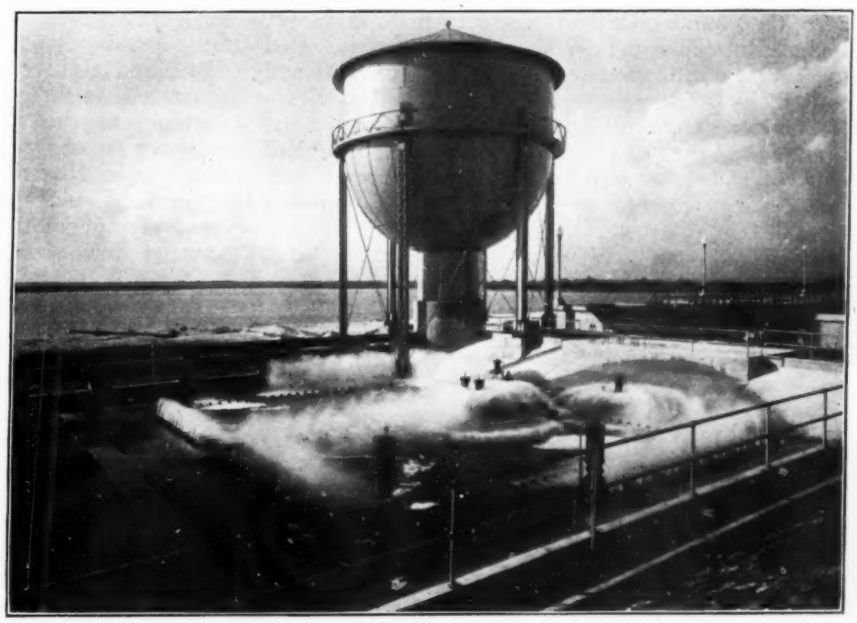
Typhoid Fever Suppression. Again, as during the past 15 years or more, the typhoid fever death rate has shown a decrease during the year just closed. Owing largely to emergency chlorination of public water supplies and careful sanitary supervision, the Mississippi and Vermont floods were not attended by typhoid outbreaks.

While much of the more recent decrease in the typhoid death rate has been brought about by other than water supply improvements, efficient filtration and chlorination of public water supplies may, beyond all doubt, be largely credited with the continued suppression of the abnormally high rates of fifteen and twenty years ago.

SEWAGE TREATMENT.

General. Progress in sewage treatment during 1927 has been marked by a decidedly increased interest on the part of the general public in the effort to limit stream pollution. Popular concern in this matter has been slowly awakening for twenty years but seems to have crystallized recently in the form of wholehearted support given to public authorities in plans for stream pollution prevention, in the almost uniform success of sewage treatment projects when submitted to the vote of taxpayers, and in a demand for legislation to make possible the effective and economical solution, by cooperative action, of sewerage and sewage disposal problems affecting adjoining districts.

Several underlying causes for this increased interest in sewage treatment may be named, such as greater density of population; the wider educational work being carried on by public health authorities; the prominence accorded to the subject by the press



WATER FILTRATION PLANT AT WEST PALM BEACH, FLA.

as, for example, in the reports of the Chicago drainage canal case; and the efforts of such organizations as the Isaak Walton League and various local associations for the conservation of fish life. The discomfort occasioned by oil pollution of bathing beaches in recent years has also centered attention on all forms of water pollution.

But the definite examples of the effects of fouling, by sewage, streams used for public water supply and the consequent economic loss resulting from indiscriminate pollution of waterways and of shellfish grounds, have probably been the most important factors in arousing the public conscience to the point where the responsibility for such conditions is not so casually evaded as formerly. A concrete case is the decision, recently forced upon the city of Albany, N. Y., to abandon the water filtration plant on the Hudson river constructed and improved from time to time over a period of nearly thirty years at a total cost of $1,600,000. Continued and increased sewage pollution of the Hudson river has thus made it necessary for this city to abandon its investment in the present filter and to seek other, less polluted sources of water supply at a cost of several million dollars.

From New York to California, in various states, new statutes or amendment and extension of existing laws have been enacted by legislatures which provide for joint sewer districts, for assessment of sewage disposal costs in a manner similar to the levying of water rates, and for legislative and departmental investigation of stream pollution problems.

Plants. At Chicago the construction of the North Side plant is well along and will be completed in 1928. This plant, which is of the activated sludge type, is expected to serve a population of 800,000 in 1930.

Also, the West Side plant, employing Imhoff tanks and designed for a population of 1,850,000 in 1940, is nearly completed at an estimated cost of $19,500,000.

The final one of the three major projects at Chicago, the Southwest Side treatment works, is not yet under contract nor fully designed but is expected to serve an estimated population of 1,230,000 and to cost, including interceptors, over $36,000,000 .

The city of Detroit has adopted the recommendation of the board of consulting engineers for a plant employing Imhoff tanks and plans are being prepared for treatment works to cost approximately $20,000,000.

Legislative authority was granted for use of a part of Ward's Island in the East river as a site for sewage treatment works to serve that part of Manhattan Island, between East 73rd and 155th Sts., from which sewage is now discharged into the East and Harlem rivers, and an organization for the design and construction of the plant is now being formed. The present population of the areas to be served, at first, by a 180 m. g. d. plant is 1,050,000, and the estimated cost of the plant is $16,000,000. It is tentatively proposed to employ the activated sludge method of sewage treatment.

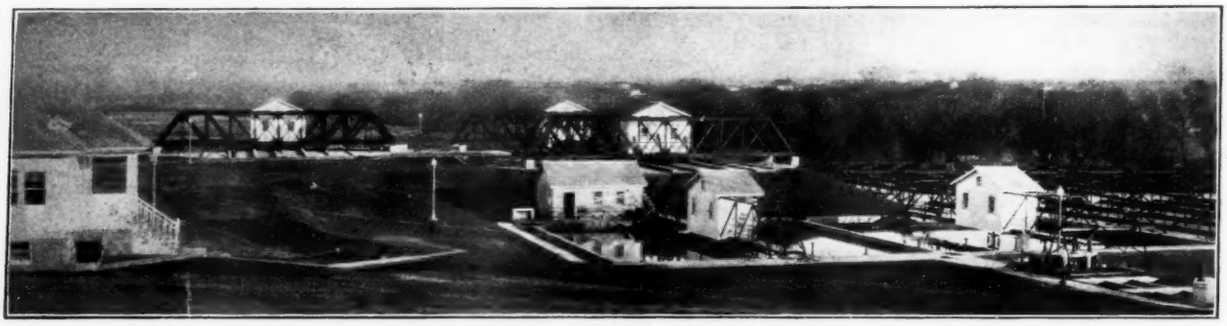
A Metropolitan Drainage Commission has been appointed to work out plans for joint sewage treatment for St. Paul and Minneapolis, Minnesota.

Numerous other sewage treatment plants are being completed or have been authorized.

The increasing favor with which the separate sludge digestion process is being met, especially in the case of the smaller projects and in locations where Imhoff tank construction is relatively expensive, is shown by the fact that nineteen separate sludge digestion plants were built in 1927, out of forty-one modern type plants so far constructed, using this method of sludge digestion. The first plant of this type which had mechanical means for continuous removal of sludge was built at Brownsville, Texas, in 1923. A photograph of a separate sludge digestion plant is reproduced herewith.

However, since 1912, according to a recent estimate by Dr. Imhoff, over 600 installations of Imhoff tanks have been made in America, and most of the larger installations, completed or projected during the past year, have included Imhoff tanks, as at Chicago (West Side plant), Detroit, Dayton, Alliance, Akron, Oklahoma City and Trenton.

Research and Improvements in Process. Considerable study and experimentation has been devoted during the year to the utilization of gas from sludge digestion as well as to the control of the digestion process itself by regulating the alkalinity as measured by the pH value through the addition of small amounts of hydrated lime, and by heating of the sludge in winter; to chlorination programs, as at Schenectady, N. Y., at Cleveland and Portsmouth, Ohio, and at several plants in Texas; and to improvement in filter underdrains and a better understanding of the ventilation of filters. The chief engineer of the Milwaukee Sewerage Commission reported in November that sludge dewatering and drying difficulties were still present, preventing treatment of more than 75 per cent of the dry weather flow of sewage.



SEWAGE TREATMENT PLANT AT SIOUX FALLS, S. D.

Sewage plant operators' associations have been formed during the year in Ohio and in West Virginia, bringing the total number of such state associations to thirteen. At present, New Jersey appears to be the only state requiring the licensing of disposal plant operators. Additional short courses of instruction for plant operators, which are usually carried on in cooperation with the state university, have been established in one or two states.

Research in sewage disposal has been continued at the Harvard Engineering School, at the New Jersey Agricultural Experiment Station, and at other points.

The principal studies of general interest in which conclusions were reached, together with the results determined during the year in the New Jersey work, as reported by Dr. Rudolfs, are as follows:

1. Studies on H_2S production, with particular reference to the effects of unfiltered seawater or other water of high sulphate content.—Addition of seawater above 12.5 per cent retards sludge digestion and at 50 per cent addition the speed of digestion is reduced one-half at 80° F (optimum).

2. The effect of comparatively small amounts of chlorides (as found in seawater) is slight.

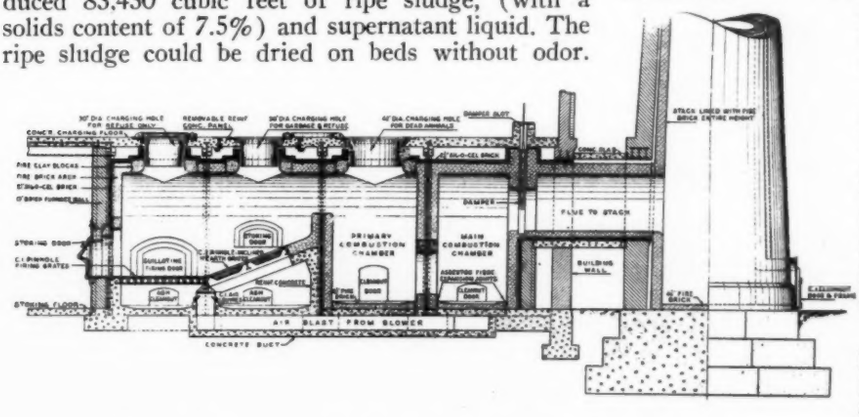
3 Sewage screenings contain comparatively large quantities of carbonaceous materials but may be digested rapidly under proper conditions.

4. Fats.—All fats may eventually be digested but not necessarily within economic limits.

5. At the optimum temperature of 80° F, the permissible daily addition of fresh solids to ripe sludge may be increased to 3.25 per cent as against 2 per cent at 70° F. From a pratical standpoint, this allows the operation of digestion tanks on a 28-day basis instead of a 40-day basis as at 70°, or in other words, a tank capacity of 40,000 cubic feet for digestion at 70° may be reduced to 28,000 cubic feet if a temperature of 80° F is maintained, with the same results.

6. Operating data on the separate sludge digestion tanks with floating covers at Plainfield show that the two tanks of a combined capacity of 40,000 cubic feet, operated on a strict schedule of definite additions of fresh solids and withdrawals of ripe sludge or supernatant liquid, daily, at a temperature of 67-68° F and average pH values of 7.3, received during nearly three months of continuous operation 91,115 cubic feet of fresh solids (4.5%) and produced 83,430 cubic feet of ripe sludge, (with a solids content of 7.5%) and supernatant liquid. The ripe sludge could be dried on beds without odor. From the figures it can be seen that the average time of digestion was 40 days, which is according to the theory at 70° F. Securing higher solids content of the sludge depends upon a longer time of digestion and therefore is a question of economy as between drying space and digestion capacity.

7. Filter fly control.—More than 75 substances were tried as possible fly controls but none has proved satisfactory. Some substances killed the larvae but were too expensive at the rate of application necessary for control.



SECTIONAL VIEW OF "U. S. STANDARD" INCINERATOR.

REFUSE DISPOSAL.

General. Activity during 1927 in the refuse disposal field has again emphasized the fact that by far the larger number of new projects in recent years comprise incinerators for disposing of mixed refuse, or garbage and rubbish, and that the present tendency is almost wholly to construct incinerators rather than to build reduction plants for grease and fertilizer recovery or, except at small communities, to arrange for final disposal by hog feeding.

The most pronounced feature of progress along this line has been the exceptionally large number of incinerators, of 20 to 40 tons rated capacity per 24 hours, constructed by municipalities of 5000 to 15,000 population. This movement seems to indicate that the opinion of municipal authorities, in general, is crystallized on the adoption of the refuse incinerator as being, even for comparatively small communities, the most certain and the most sanitary method and as being of reasonable cost. Additional evidence of this general decision lies in the fact that pre-formed opinion of public officials is centered on incineration in a majority of cases even before an engineer is called in to study the general problem.

A section through a modern type, high temperature mixed refuse incinerator is reproduced herewith.

Plants. The Buffalo incinerator of 450 tons capacity was put in operation in February, 1927. The largest incinerator so far constructed in this country is being completed at Los Angeles. It is of the Dutch oven type and will have a capacity of 800 tons daily, in 100-ton units.

Three incinerators are being completed for Birmingham. At Toledo, two are being built. An incinerator for Philadelphia of 200 tons capacity, and one for Providence of 160 tons capacity, are under construction.

Four mixed refuse incinerators have been completed in New York City during the year, the Astoria plant of 270 tons capacity, and the Great Kills, Jamaica, and the 73rd Street plants, the latter having a capacity of 320 tons daily.

At Cleveland a reduction plant is being planned, this plant, so far as records are available, being the only large plant of this type definitely

decided upon since the Indianapolis reduction plant was completed about a year ago.

RESUME.

Altogether, the year has been one of considerable accomplishment in the construction of sanitary engineering works, of renewed and widespread interest in the technical problems to be met and in improved technique desired, and of extensive planning for future projects backed by an increasing public support.

Concrete Pressure Pipe in Birmingham

Method of constructing and laying pipe used in the expansion program of the Birmingham Water Works Company.

By K. W. Grimley*

The past ten years have witnessed an enormous development of the industrial South. This has been particularly noticeable in Birmingham, Alabama, and surrounding districts, where exploitation of the natural resources of iron and coal has progressed rapidly. The continued growth in population and manufacturing has resulted in ever-increasing demands for water, the increase having been fairly uniform from 4,900 million gallons in 1922 to 8,120 million in 1926.

Birmingham's public water supply is furnished by The Birmingham Water Works Company. Its main source of supply is from the Cahaba river, supplemented by Five Mile creek. (The Birmingham water works was described in PUBLIC WORKS for May 13, 1922.) Due to the continued growth of the city, the water company has recently engaged upon an expansion program which, besides increasing storage capacity, enlarging the filteration plant and pumping facilities, calls for the installation of additional reinforcing and transmission mains.

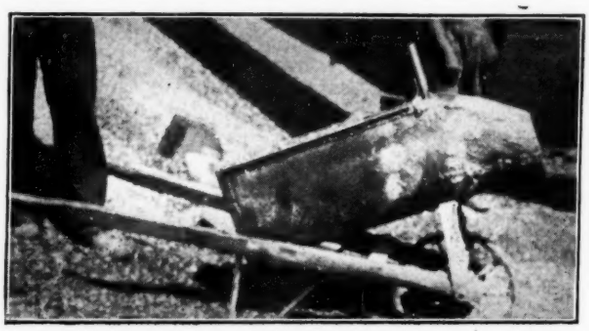
The company is now actively engaged in laying a 42 inch transmission main from its filter plant on Shades Mountain to the west end of the city, a distance of over seven miles. The contract for this line, 41,500 feet long, was given to the Lock Joint Pipe Co., of Ampere, N. J. Each section of pipe is 12 feet long and weighs approximately four tons. About 1,000 pounds of reinforcing steel and two yards of 1:1½:1¾ concrete are used to a length; the coarse aggregate consisting of ¾-inch gravel.

A construction plant equipped to manufacture the pipe complete, was erected especially for this contract on a spur of the Louisville & Nashville Railroad near the location of the new pipe line, thus obtaining a short haul with resulting economy.

In making a section, three 4-foot by 12-foot plates are bent and welded to form a cylinder of steel. Inside of this cylinder welded mesh reinforcement is placed to bond and strengthen the concrete. Outside of the cylinder is assembled a cage of steel mesh or bars. The cylinder is then placed on end in a steel form and the concrete poured. The section is cured for 3 days in steam, followed by ten days in the yard.

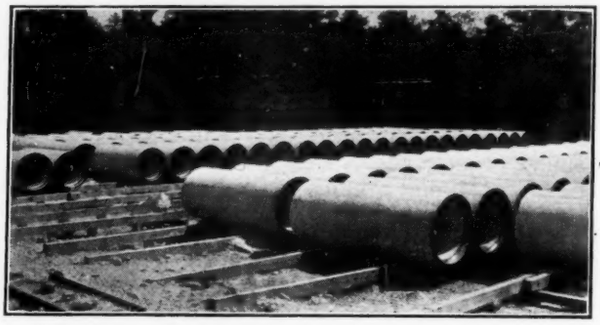
The plant is arranged for maximum efficiency. Located on a gentle slope below the railroad siding, almost all transportation of materials is by gravity. Aggregates for the concrete are dumped from the cars into bins located behind a battery of three power mixers. Here it is accurately measured by means of special wheelbarrows, and conveyed to the mixers. After mixing, the concrete is discharged by gravity through a chute into a ladle handled by a crane, which lifts it to the top of one of the pouring platforms above the pipe forms, where it is discharged through a bottom gate into the form.

The steel department contains all modern tools, machines and equipment necessary for



WHEELBARROW FOR MEASURING CONCRETE AGGREGATES.

PIPE CONSTRUCTION PLANT.



CURING CONCRETE PIPE IN YARD.

*Sanitary engineer, Birmingham Board of Health.

PREPARING TO BLAST TRENCH IN ROCK.

EXCAVATING TRENCH.

USING SHOVEL FOR LAYING PIPE.

bending and welding plates and mesh reinforcement and other metal work. The same crane which elevates the concrete mix is used to transport the completed reinforcement to place in the yard.

In addition to the necessary housing for the manufacturing equipment, an office and headquarters for construction has been erected.

LOWERING PIPE INTO TRENCH.

HORIZONTAL AND VERTICAL CURVES IN PIPE.

The plant employs 60 men on pipe construction and turns out twenty-four 12-foot sections in an eight hour day. Construction of pipe began in March, 1927, and is scheduled to be complete by June 1, 1928.

The actual work of trenching and laying the pipe is rendered difficult by the rugged topography encountered along the right-of-way. Two high mountains and two steep and sharp ridges must be crossed by the pipe line. A constant source of worry is a low-hung power line carrying 10,000 volts which extends overhead for a

considerable part of the way, making it impossible or extremely undesirable in some places to raise the crane booms, and creating a "mental hazard" of quite some magnitude.

As a preliminary to trenching, a blasting crew equipped with three drills powered by a Sullivan and a Chicago compressor break up rock wherever it is encountered. A double row of holes are drilled approximately 30 inches on centers and are shot with Dupont 40 per cent. dynamite.

The trenching crew operates a Northwest "Trench Hoe" or pull-shovel, which is used for all excavation. Should the shovel get too far ahead of the pipe laying crew, it is also used to lay and cover pipe until this work catches up with the trenching.

Pipe is transported from the plant yard to the right-of-way on trucks. Each truck is constructed with a special wooden cradle, capable of supporting two sections of pipe side by side. It is unloaded by hand or by either operating unit.

The pipe laying crew is equipped with an American steam crane, which lifts the pipe sections directly from a truck to place or to the ground. The crane also backfills with a drag. At the summit of each crest along the line, a concrete anchor is cast in place around the pipe, to prevent the forward line from slipping downhill.

Both the crane and trencher work continuously. A total of fifty men are employed in the field, laying on the average 300 feet of pipe per day. W. R. Brend is local superintendent for the Lock Joint Pipe Company, and W. R. Abbott assistant superintendent.

Operation of Milwaukee Sewage Treatment Plant

The Milwaukee Sewage Disposal Plant, serving a population of approximately 600,000 and treating at present 86 million gallons of sewage every 24 hours, is the largest activated sludge plant in operation in the world today. It is the only sewage disposal plant that manufactures a commercial fertilizer in large quantities and actually markets it successfully.

An outline of the construction and operation of this plant was given in the January, 1924, issue of Public Works. *A paper describing the operation of the plant, giving the cost of operation and the results obtained, was presented before the American Society for Municipal Improvements by Robert Cramer, chief engineer, and John Arthur Wilson, consulting chemist, of the Sewerage Commission of Milwaukee. The authors prefaced their article with a brief description of the plant, which follows exactly that given in our article above referred to, with the addition of some information concerning operating details. This information we are giving below, followed by the balance of the paper complete as presented. This paper should be of the greatest interest to all who endeavor to keep informed on sewage treatment matters.*

At the Milwaukee sewage treatment plant the raw sewage, after passing through coarse and fine screens ($\frac{3}{16}$ inch slots), flows through a mixing channel where activated sludge is mixed with it. The rate of flow of the mixed liquor is regulated so that it takes six hours for it to travel through the aeration tank, during which time 1.5 cubic feet of air is bubbled through it for each gallon of raw sewage entering the system.

The sludge drawn off from the bottom of the sedimentation tanks, containing about 2% of solid matter, flows through two parallel concrete conduits and a concrete tunnel to a sludge well. From here about 90% of the sludge is pumped to the mixing channel just referred to. The sewage contains about 300 parts per million of suspended matter and enough returned sludge is added so as to increase this value ten times in the mixed liquor before it starts its journey through the aeration tanks. An amount of sludge equivalent to the solids which are introduced into the plant by the raw sewage is removed to the dewatering plant where it is filtered and dried.

The waste activated sludge flows first into a 42,000 gallon acidification tank, where it is treated with the amount of sulphuric acid or ferric chloride necessary to give the filter effluent a pH value of 3.4. This tank is equipped with diffuser plates and baffles to permit thorough mixing. The flow of acid is regulated by a control chemist who tests the filter effluents periodically.

When the sludge is dried in the Atlas direct-indirect-heat continuous rotary dryers, there is a tendency for the sludge to ball up and dry irregularly in the dryers; to remedy which, an equal quantity of previously dried sludge is mixed with the sludge cake from the filters while it is in the conveyors. This lowers the moisture content sufficiently to prevent balling. As the drum revolves, the hot gases from the furnace, mixed with large volumes of outside air, circulate around and into the drum through numerous air valves attached to the drum shell. About 45 minutes is allowed for the sludge to pass through the driers. The sludge cake coming from the filters has an average water content of about 83 per cent. After it has passed through the driers its water content is only from 5 to 10 per cent.

The dried material is conveyed to rotary screens, from which the finer particles are transported to the storage house by belt conveyors. The coarser particles are passed through a pulverator and are then

conveyed back and discharged into the wet-sludge-cake conveyor.

The plant is now in uninterrupted operation, except that at times of heavy rain or thaw practically all sewage solids go into the rivers and the lake untreated but highly diluted, due to the fact that most of the sewer system is of the combined type, and could not be changed except at enormous cost. The purification, judged by removal of suspended solids, bacteria count, or oxygen demand, is practically perfect, and far better than in any other plant of which we have knowledge. The final disposal of the removed solids in the form of a commercial fertilizer seems fully assured, as long as present market conditions prevail, which permit us to sell and ship the material as fast as we produce it.

"Milorganite", average analysis:.

Moisture	4%
Ash	30%
Nitrogen as NH_3	6.5 to 7.5%
Total phosphoric acid	2.75%
Available phosphoric acid	2.20%
Ether soluble matter	6.5 to 7.5%

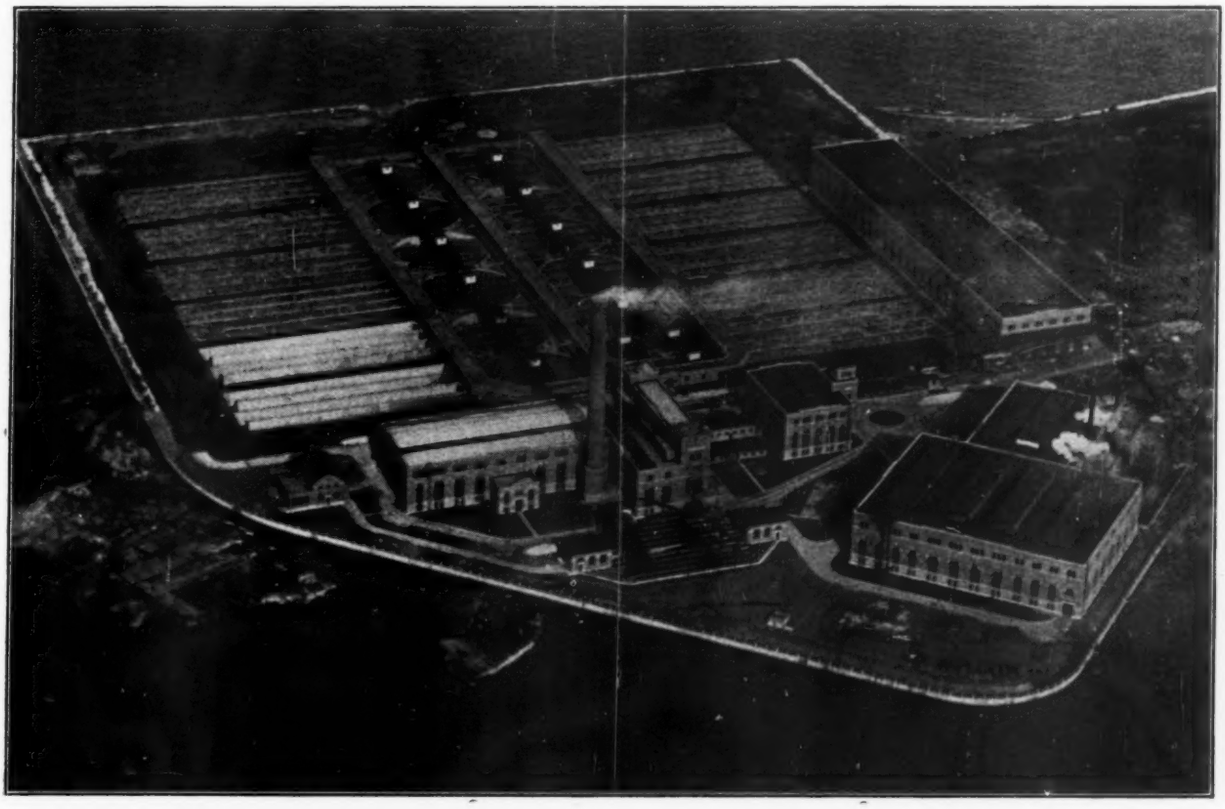
OPERATING DIFFICULTIES.

The period of construction of this plant ended practically at the beginning of 1926, when the attempt was made to put it into regular operation. Many difficulties developed at that time. These were due mainly to four causes:

First. Some of the equipment proved inadequate to perform the work for which it was intended. To cite only two examples: The centrifugal pumps which delivered the waste sludge to the filters, so broke up the material that filtering could be accomplished only under otherwise most favorable conditions, such as prevail during the summer. These pumps were replaced by plunger pumps, which proved inadequate in capacity and corroded rapidly as a result of the chemical sludge conditioning which is practiced in order to make the sludge more readily filterable. These pumps are now being rebuilt, using corrosion-resisting bronze, and are being augmented by the installation of additional ones.

The dryers proved inadequate in capacity and it became necessary to rebuild their brick settings and to rearrange some details of the drums.

Secondly. The treatment of the sludge, before filtering, by sulphuric acid and heat was not always successful. Acid treatment alone, as was known, is



AIRPLANE VIEW OF MILWAUKEE SEWAGE TREATMENT PLANT.

OPERATING RESULTS

The average characteristics of sewage, effluent and fertilizer, as shown by our records of operation, are as follows:

	Sewage after leaving fine screen	Plant effluent
Total solids p. p. m.	1000	750
Dissolved solids p. p. m.	700	725
Suspended solids p. p. m.	300	25
Bacteria count (20 deg. C Agar 48 hrs.)	over 3,000,000	40,000
B. O. D. p. p. m. 20 deg. 5 day incub.	200-250	0-6
Stability hours		120 plus
Suspended solids removal	92%	
Bacteria removal	98.5%	
Nitrogen total as NH_3	35	4.5
Nitrates		4
Nitrites		less than 1%

insufficient during practically the colder half of the year, and the apparatus installed for heating proved impractical. To meet this situation, the attempts to use the heating apparatus were abandoned, and chemicals other than sulphuric acid were tried. Among these the most effective was found to be ferric chloride. At present this is not used as such because of its high cost, but we use, according to the season of the year, sulphuric acid, aluminum sulfate or ferrous sulphate-ferric chloride, which is made in the plant by introducing liquid chlorine into a solution of copperas. At times combinations of these are used, the selection of the treatment being made on the basis of cost and of necessity of effecting a certain reduction of filtering time in order to be able to handle the material on the Oliver filters.

Third. It became necessary to acquire skill and experience in the operation of much of the apparatus. At present, for instance, we operate the dryers at a steady output of about 18 tons per dryer per day, and the temperatures in the different parts of the furnace and setting remain so constant that the pyrometer chart record appears as if drawn with a ruler. Formerly both output and temperatures varied greatly. At times of large storm water flow or thaws we now manipulate the plants so that regular operation is resumed without difficulty as soon as the unusual condition has passed. We turn out fertilizer which conforms to strict specifications as to moisture and dust content and size of particles.

Fourth. The organization of the operating force proved inadequate. It was realized that the operation of this large and complicated plant presented the same kind of problem as the operation of any large industrial establishment. The lines of organization must be strictly drawn and all responsibility from the top down to the last task, must be placed on shoulders able and willing to carry it.

By meeting these difficulties the amount of sewage handled by the plant was gradually increased. At this time the amount being treated regularly is 86 million gallons daily, dry weather flow, which is the amount for which the present installation was designed, but is less than the sewage being produced in the metropolitan district which is served by the plant. It is estimated that the total dry weather flow is now 100 million gallons daily.

Many parts of the plant, notably the filtering and drying machinery, seem to have reached their capacity. It will probably be possible, by careful handling, to filter and dry the sludge from the present dry weather flow, but any future increase must be cared for either by new methods of increasing capacities (for which experimentation is in progress) or by installation of additional apparatus.

On the other hand, experiments made in our testing station seem to indicate that the capacity of our aeration units may be greatly increased. These tests, while not merely laboratory demonstrations, were made on plants many times smaller than the large plant, and in apparatus somewhat different in proportion. They seem so promising, however, that we have decided to experiment further with full-size units. This work is of great importance and significance because of the possibility of its leading to great reductions of operating costs.

Four of the minor by-products of the process have presented difficulties. These are: 1.—the coarse screenings. 2.—the grit. 3.—the fine screenings; and 4.—the dust being produced in the process of drying sludge.

We have demonstrated that the dust can be handled either by discharging it into the sewage, where it becomes again incorporated in the activated sludge, or by mixing it with the coal which is burned in the boiler furnaces.

We have demonstrated that screenings can be digested in separate tanks. The resulting sludge can be handled on drying beds of conventional design, which should be covered in a climate such as that of Milwaukee; but we intend to test the possibility of mixing this sludge with that which goes to the filters. We have begun an installation which will demonstrate these possibilities on a large scale, and we are preparing to test the disposal of screenings by cooking at high temperature, followed by drying under vacuum, and disposal of the product by sale in the fertilizer market.

We have disposed of some grit as fill. The problem is not pressing now, but may become so in the future.

Minor but annoying operating difficulties were caused by complaints about the odor of the dryer discharge. This odor was never very intense, nor is it very offensive. It resembles the odor of a swamp mixed with that produced when malt is burned. We are now meeting these complaints by the temporary expedient of chlorinating the dryer discharge whenever the wind carries the same toward the city; this method of meeting the odor problem being practiced pending the investigation of other methods.

OPERATING COST.

Having reached the point of reliable operation of the equipment as now installed, we are about to enter the next phase—the reduction of operating costs. In order to judge the economic possibilities it is necessary to analyse the operating costs that prevail at this time.

For making this analysis, the capital charge will not be included, because to do so would be misleading. The cost of constructing the plant was abnormally high, for several reasons:

1. The layout of the plant, while excellent from the standpoint of hydraulics and movement of the material through the successive stages of treatment, was not planned with economy of construction in mind.

2. Some of the machinery which was installed is not used, and some has been replaced by other apparatus.

3. Additions to the originally installed equipment became necessary.

Also the operating costs, as they now appear on our records, are misleading, because they contain labor items due to additional construction and reconstruction, and other items due to faulty operating conditions which are being corrected as rapidly as possible.

These conditions can now be clearly understood and appraised, and an operating cost set down which we are certain we can attain in the near

future. Separated into major divisions only, this annual operating cost appears as follows:

Payroll and administration	$320,000
Coal, 60,000 tons at $5.00	300,000
Chemicals	150,000
Supplies	50,000
Repairs, maintenance	100,000
Insurance, sales and misc. expenses	30,000
Total	$950,000

Against this is to be credited the return from the sale of fertilizer, the annual amount of which is estimated as follows: 365 days less 18% for rain and thaw, or 65 days, gives 300 days; which at 100 tons a day gives 30,000 tons a year; and this at $14.75 a ton gives $442,500. Deducting this from $950,000 gives a net operating cost of $507,500.

The net return of $14.75 per ton of "Milorganite" (the trade name adopted for our product) is the actual record of 1927. This net operating cost amounts to $1,430 per day, or $14.30 per million gallons treated.

The above figures are based on the present estimated total dry weather flow of 100 m. g. d., and an estimated return of 1 ton of Milorganite per million gallons. The present indications are that the average return will be only slightly greater than this.

FUTURE IMPROVEMENTS.

There are possibilities of reducing this operating cost.

The item given as "Payroll and administration" represents a working force of about 200 men, or 70 men on each of the three shifts needed for a day and night operation. This includes the men who operate the power plant, no outside power being bought. The cost of producing this power is high, and it should be borne in mind that power could probably be bought cheaper than we can produce it. The conditions for contracting for power at the lowest rates are ideal in large sewage disposal plants, as the load is practically constant, and may even be arranged as an "off-peak" load.

In our particular case these considerations have no immediate practical value, because the investment in the power plant has been made and the corresponding fixed charges must be met.

The item for coal, 165 tons per day, is roughly divided into 100 tons used in the power house and 65 tons in the dryer house. The amount used in the power house varies slightly, being less in summer and more during the heating season, but the variation is not enough to modify the picture.

It is this item of coal which offers the greatest possibilities of saving. The amount of air used averages 1½ cubic feet per gallon of sewage treated. The purification of the effluent could be maintained with a good deal less air, but we have found that excessive aeration must be practiced in order to filter the sludge successfully.

In order to study this important aspect of our process we installed the testing station referred to earlier in this paper. This consists of four small treatment plants, each complete in itself and arranged to carry out in every detail the process in the large plant. The four plants can be operated so that only one factor affecting the operation is varied, every other factor being held the same in all four. Thus the effect of such variation can be studied under rigidly controlled conditions.

In this testing plant we have successfully treated sewage at three times the rate in gallons per cubic foot of air, as compared with the main plant, and have produced a sludge that can be successfully filtered. We have not repeated these results on the full scale of the large plant. Eventually the attempt will be made to carry out this step, but this must be done with all the safeguards and precautions necessary to insure that we will continue to treat the full sewage flow without interruption.

About 80% of the coal burned in the power house is used for compressing the air used in the aeration tanks. This is equal to 48% of the total coal burned. A reduction such as indicated by our testing station work may thus result in a 32% saving of coal, and may also increase the capacity of one of the most costly parts of our plant.

While our testing work clearly indicates these possibilities, the problem of carrying them out is a difficult one.

About 40% of the coal consumed is used in the dryer house. With our present arrangement the operation of the dryer house is entirely independent of the power production. The one great advantage of producing power in an industrial plant is dependent upon the condition that large amounts of heat are needed under such condition that this heat may be obtained from the exhaust steam of the non-condensing power units. In our case the relative amounts of power and heat requirements, and the perfectly steady and uniform demand for both, would seem to offer ideal conditions, and possibilities for great reduction of coal consumption. On the other hand, the process of drying, if carried out as we practice it now, at temperatures up to 1800° Fahr., could not be handled with exhaust steam even if the back pressure of the power units were carried as high as practical. Several methods of pre-drying by means of exhaust steam are now under consideration. Even if the filter cake is only partly dried by heat obtained from exhaust steam, such a process would result not only in coal saving, but would increase the capacity of our dryer installation, the limit of which we have reached under present conditions of operation.

The item set down for chemicals includes $30,000 for chlorine for deodorizing the dryer discharge. This may be replaced by less costly methods, but no definite information is as yet available. The rest of this item is required for treatment of the sludge before it goes to the filters, except for a relatively small amount for laboratory supplies. At present no reduction of this item appears feasible, except that we are learning to be economical through the accumulated experience of continued operation.

The figure given for repairs and maintenance is an estimated one, based on our short experience and a reasonable forecast of the future. It does not include expenditures made for rebuilding and replacing machinery which proved unsuitable for the work.

Site for Detroit Sewage Treatment Plant

Proceedings have been begun by Detroit, Mich., to acquire a site for the proposed sewage treatment plant to serve the entire city. Present plans call

for detritus and Imhoff tanks and disinfection of the effluent with liquid chlorine, the plant to be located within the limits of the municipality of River Rouge, which community opposes the plan. Under the present law, a favorable vote is necessary by the citizens of River Rouge to permit the construction, and an election for this purpose can be called only by a two-thirds vote of the governing body. Litigation on the subject will probably ensue.

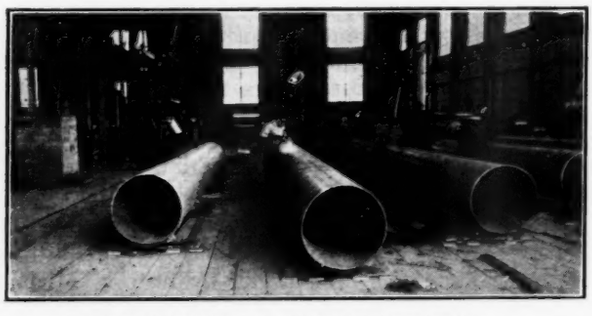
Large Pipe Line Shipped As Boiler Plate

Excessive freight cost avoided by fabrication on the job. Welding employed in both shop and trench.

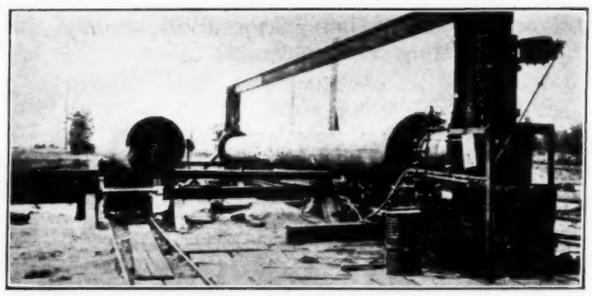
In localities remote from the base of supplies, freight rates on heavy or bulky materials are often so high as to become prohibitive. In the Pacific Coast region this applies to large-diameter steel pipe, which must be purchased back east. The engineers of a gas and coke company in Oregon, having decided to lay more than seven miles of 36-inch and 30-inch steel pipe, were confronted by this problem, which they solved by ordering flat boiler plates, shipped from the eastern mills by way of the Panama Canal at a much lower freight rate than the equivalent pipe.

The pipe was made from the plates by bending them into rings and oxwelding the joints. The gas company did not do the actual welding, but let the contract to an outside concern making a specialty of such work. In fact, two welding contracts were let, both of which were secured by the same concern. One contract covered the fabrication of 36-ft. lengths in the shop; the other provided that the gas company was to take delivery of the pipe at the shops, string it, line it up, do the ditching and back filling; in short, everything except the actual welding. The oxwelding was to be done by the contractor on a so-much-per-linear-foot-of-welding basis; or, if unforseen conditions should arise that would in any way delay the welders, then compensation was to be figured on an hourly basis.

A pipe line of this size and length, completely fabricated by welding, had not been undertaken before, although the general practice has become well standardized within the last two or three years. It was, therefore, rather difficult to estimate accurately just how much time would be required. It was estimated that the job would be completed in about eight months after operations had been started in the shop.



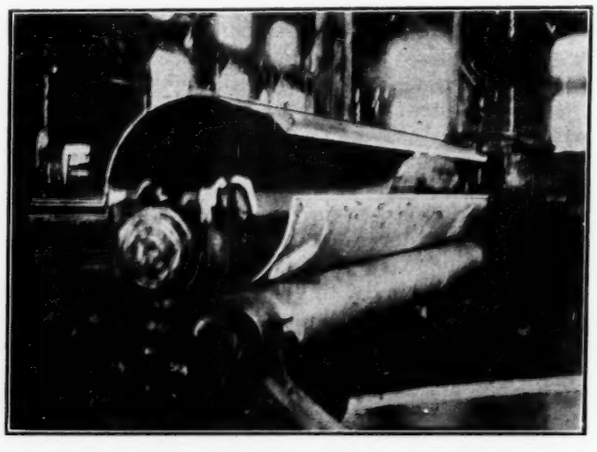
SHOP WHERE WELDING WAS DONE.



A LENGTH OF PIPE UNDERGOING 150-POUND HYDROSTATIC TEST.

Before starting, a "procedure control" for fabricating pipe by oxwelding was worked out. This was followed to the letter by the contractor and a service operator trained in oxwelding practices was on hand to aid in the interpretation of the procedure control and to help in training the welders. As a result of this careful planning, the work of fabrication was completed in four months and a half, and the welding of the line in the field was finished about two months later. Some delay was experienced in the pipe laying, due to the fact that the ditcher encountered a long-abandoned macadam roadbed under the surface, the existence of which had been forgotten. This hard layer slowed down the ditching operation to about 500 ft. per day.

The plates, which were 5/16-in. thick and came in 12-ft. lengths, were first shear-beveled on the sides and ends to an angle of about 45 deg. to form the vees for welding. They were then passed through a set of rolls to bend them into rings. It was found that the large rolls would not curve the plates all the way out to the edges, so a special roll was rigged up to form the edges to the proper curvature before feeding the plates to the large rolls. After the longitudinal seams had been welded, three of the courses or rings were lined up on rollers and the circumferential seams welded, thus forming a 36-ft. length of pipe. During the latter operation the work was continuously rotated so that the weld was always in a position convenient for the operator. Welding



ROLLING PLATE FOR PIPE SECTION.

crews consisted of 7 men on the longitudinal seams and 4 men on the circumferential seams.

After the 36-ft. lengths had been fabricated, they were transported to the yard on a narrow-gauge track for test. First 150 lb. hydrostatic pressure was applied, and while under pressure the welds were hammered with a 12-lb. sledge. The water was then drained and the lengths given an air test of 50 lbs. Soapy water was painted over the welds with a brush to locate any leaks that had developed under the hydrostatic pressure. Of the hundreds of joints tested, very few leaks appeared, and these were mere pin holes which were closed by caulking. Only three joints were returned to the shop to be rewelded.

After testing, lengths were shunted to the dipping tanks, where they were passed in succession through a hot alkali solution to remove grease, hot dilute sulphuric acid to clean off scale, an alkaline neutralizing bath, and a hot water rinse. Drying by means of gas flames played on the inside of the pipe completed the perliminary treatment. Lengths were then capped at each end, dipped in asphaltum, and while still warm rolled in grit. The caps served not only to keep asphalt from the interior of the pipe but also to maintain uncoated a 3 or 4-in. band at each end to facilitate welding. After welding had been completed in the field, this band of pipe at the weld was in turn coated with asphalt paint and sprinkled with grit.

In the field work in connection with this line, the same methods were employed that have been used on thousands of miles of welded lines constructed during the last two or three years. Using a portable crane for handling, three 36-ft. lengths were welded into a 108-ft. section on skids over the trench. This section was then tied in to the pipe line already completed and lowered into the trench.

Experience has proved that it is the best engineering practice to offset adjacent longitudinal seams 120 deg. of arc. The soundness of this principle was recognized, but after careful consideration, it was decided that it would be more desirable to offset the seams only 22½ deg., or 14 in. This brought all the seams near the top of the pipe, ready for final inspection.

Physical Properties of Water-Bearing Soils

The need of more definite data in regard to the hydrologic properties of water-bearing materials has long been recognized by geologists and engineers. With the increase in importance of water-supply studies has come a demand for definite and accurate methods of testing samples of water-bearing sands and rocks. To meet this need the Geological Survey, Department of the Interior, established a hydrologic laboratory and has just issued a report by Norah Dowell Stearns as Water-Supply Paper 596-F on the methods used and the results obtained in testing the physical properties of numerous water-bearing and non-water-bearing materials collected in New Jersey, Montana, and Idaho.

The tests consisted of mechanical analyses, determinations of porosity, moisture equivalent, and permeability. In making the permeability tests it was desirable to use low hydraulic gradients, of the same order of magnitude as those found in nature. For this purpose an apparatus was devised and built in the Geological Survey in which a percolation cylinder with a column of material 1 meter in height was used and in which the head could be reduced to a fraction of 1 millimeter. This apparatus gave good results with heads as low as 1 millimeter or hydraulic gradients as low as 5 feet to the mile, and was kept in operation continuously for several days under an apparent head of about a fifth of a millimeter or a gradient of only 1 foot to the mile. Under a head of 1 millimeter the percolation amounted to only about 1 drop in a minute.

DISTRIBUTING THE 36-FOOT SECTIONS.

COMPLETING WELDING OF TRENCH JOINT.

Another experiment was performed which showed in an impressive manner that movement under hydrostatic pressure may be continuous even though the velocity is extremely slow. In this experiment it was found that water percolated through a fine silty material at the rate of about half an inch in 133 days, which would be about 1 foot in 10 years, or 1 mile in 50,000 years.

Precise Weir Measurements

Study of several thousand measurements of discharge over sharp-crested weirs lead to important conclusions as to velocity of approach, head over weir and condition of weir plate.

A paper with this title occupies 110 pages of the September issue of the "Proceedings" of the American Society of Civil Engineers, the author being Ernest W. Schoder, Professor of Experimental Hydraulics, and the late Kenneth B. Turner, formerly Assistant Professor of Hydraulics, both of Cornell University. The paper presents the results of extensive new volumetric measurements of the discharge over weirs of the sharp-crested (or nearly sharp) type, without end contraction, and gives the details of these measurements in more than 40 pages of tables and 26 pages of diagrams. Following is a synopsis of the tests and the conclusions therefrom.

GENERAL

The heights of the weirs ranged from 0.5 to 7.5 ft.; the heads, from 0.012 to 2.75 ft., and the widths of channel, from 0.9 to 4.2 ft. Included in the paper are the results of 2,438 separate volumetric measurements of discharge for 1 512 different heads, all made at Cornell University and now published for the first time. Of these, 1,276 measurements for 530 heads were made by the writers. The distribution of the velocities in the channel of approach was measured by current meter for 241 heads (196 by the writers), including many cases with abnormally high velocities near the surface and near the bottom. The experiments were made at various times between 1904 and 1920, with the major part between 1913 and 1916.

FINDINGS

The main findings are:

(1) Considerable limitation should be understood as to the widespread idea that a precision in discharge estimates within 1% or 2% is obtainable merely (*a*) by careful observations of the head of water on a weir having nominally a sharp square edge, but built without precise regard to the degree of sharpness and smoothness of the crest plate and to the velocity conditions in the channel of approach; and (*b*) by the use of the standard formulas or other estimating devices of present engineering practice.

(2) The use of the simple Francis weir formula:

$$Q = 3.33\ L\ h^{3/2},\ \text{or}\ Q = 0.623 \times \frac{2}{3}\ L\ h \sqrt{2\ g\ h}$$

as a basic formula is substantiated for cases closely approximating the ideal weir with a truly sharp, square edge, with smooth, vertical, up-stream face near the crest, and with a deep up-stream pool, or with negligible effect of velocity of approach. (For low heads, see Item (5)).

(3) This paper shows the extent and nature of the inadequacy, for general precise work, of formulas that introduce merely the mean velocity of approach; or that, as the equivalent, introduce merely the height of weir; also the inadequacy of curves and tables that merely average or approximate the data of the experiments hitherto published. This inadequacy consists chiefly in the failure of the experimenters to measure and place on record the distributions of velocities in the channel of approach. The mere statement that velocities were approximately equalized by baffles leaves the matter too uncertain except for a limited range of heads and heights.

(4) The new experimental data (by several experimenters) agree with those of Francis, Fteley and Stearns, and Rehbock, in their evidence that Bazin's coefficients and formula for sharp-crested weirs give too high discharges for low heads—by fully 2 to 3% for heads of 0.3 ft. to 1.2 ft.

(5) For low heads of less than about 0.4 ft. for weirs more than 2 ft. high: (*a*) an additive corrective expression of the Fteley and Stearns' type, but made to the simple Francis formula, $Q=3.33\ L\ h^{3/2}+0.007\ L$, is verified, although their value of 0.007 ft-sec. units is to be replaced by other values ranging from 0.004 to 0.012 in certain cases; (*b*) many data of percentage corrections for extremely low heads (less than 0.10 ft.) on a variety of crest pieces are graphically shown.

(6) The percentage increase in discharge (as compared with sharp-crested conditions) due to a slight rounding of the up-stream top corner of the crest (say, to as much as 1/24-in. radius=about 1 mm., which may soon occur with exposed steel and which has been overlooked or neglected in cases intended to be "sharp-crested") is shown to be as much as 2% for heads of 0.50 ft. and 0.5% for heads of 1.35 ft. A rounding of ⅛-in. radius causes about 3%, and one of ¼-in. radius, about 5½%, increased discharge at 0.50-ft. head. Agreement is found with Fteley and Stearns' data for the larger roundings.

(7) The percentage increase in discharge due to changing the roughness of the up-stream face of the weir bulkhead from that of a polished brass plate to that of a coarse file for a distance of 12 in. below the crest is shown to range from about 2% for 0.50-ft. head to about 1% for 1.35-ft. head. This agrees with the previous findings of James Barr tor V-notched weirs.

(8) The new data show no justification for a taboo on a weir with a head of water as great as, or greater than, the height of the crest above the bottom of the channel. When the use of such a weir is convenient, the new formula, involving auxiliary

velocity measurements, and several simpler formulas are amply accurate. In fact, there seems to be an inherent certainty of action for the very high heads on very low weirs.

(9) While the importance of careful measurements of heads, including the precise referencing of the gauge to crest level (zero determination) and the use of appropriate instruments, are not to be minimized, yet all the writers' work substantiates the conclusions of earlier experimenters that there is no necessity for slavish imitations in the precise manner of determining the head, nor for a precise location of station up stream from the weir to agree with a particular experimenter, provided no violence is done to the general hydraulic circumstances. Hitherto, many errors have been charged to insignificant details of the head determination when the trouble has been due to the lack of appreciation of other factors and to neglect in making proper arrangements or measurements.

As a general rule, rarely subject to exceptions, the head should be determined in one of two ways: (1) by a direct measurement in the channel of approach (by one of several appropriate devices; or (2) by a piezometer with a stilling-well such that no correction is necessary.

(10) For precision it is necessary to deal not (as in most formulas) with the head corresponding to the mean velocity of approach, but with the head corresponding to the velocity above the level of the weir crest. This involves auxiliary measurements by current meter, Pitot tube, or floats, etc.

Where it is possible actually to duplicate the definitely known velocity conditions prevailing for different heads and heights in the channel of approach, the use of a special formula or special coefficients fitting the particular case remains entirely proper.

The extreme difference in discharge due to altering the distribution of velocities up stream from a weir, keeping the head constant, amounted to 26 per cent. The auxiliary velocity measurements by the writers and the introduction of this new factor are, in fact, simply carrying to a logical conclusion the suggestions of J. B. Francis, Hamilton Smith, Fteley and Stearns, Bazin, and others.

(11) A tentative formula,

$$Q = 3.33\ L \left[\left(h + \frac{V\ a^2}{2g} \right)^{\frac{3}{2}} + \left(\frac{V\ b^2}{2g} \times h \right) \right]$$

is suggested, in which, $\frac{V\ a^2}{2g}$ is the mean velocity head of approach above the crest level, and $\frac{V\ b^2}{2g}$ the mean velocity head of approach below the crest level, (See Item (14).) If the velocity conditions are unknown it is necessary to make measurements to find the distribution. This formula is tested by its application to the new experimental data and is found to fit all of them much better than the formulas of Fteley and Stearns, or of Bazin, or the curves of Lyman or the formula,

$$Q = 3.33\ L \left(h + \frac{V\ a^2}{2g} \right)^{\frac{3}{2}}$$

In extreme cases of high heads on low weirs the corrective terms modify as much as 50% the value that would be obtained by the simple Francis formula, $Q = 3.33\ L\ h^{3/2}$, but, nevertheless, they fit the volumetric measurements within about 1 per cent. Other simpler formulas of limited applicability are suggested also. In particular, attention is called to Rehbock's formula, $Q = \frac{2}{3} w\ L\ h \sqrt{2\ g\ h}$ which, $w = 0.605 + \frac{1}{320\ h - 3} + 0.08 \frac{h}{d_o}$ in foot-second units (d_o is the height of the weir).

(The experimental data of Francis, Fteley and Stearns, Bazin, etc., cannot be used to test the new formula because no adequate velocity measurements were made).

(12) The use of such a weir properly built, of good head measurements and good auxiliary velocity measurements in the channel of approach, should insure discharge values within 2% of the truth, and in most cases within 1%. However, this seems to be quite untrue for many weirs relied on for such a precision by the use of formulas and methods in common use.

(13) The paper in no way presumes to champion the sharp-crested weir as a measuring device superior to others.

Aerial Surveys for Line Location

Successful use by Hydro-Electric Power Commission of Ontario for locating two hundred miles of line through rough, inaccessible land.

The Hydro-Electric Power Commission of Ontario has recently employed aerial surveying for the location of a transmission line 200 miles long through rough country north of Lake Ontario, extending east northeast from Toronto. The first 80 miles from Toronto crosses well settled agricultural land, with scattered bush, rolling in places; but the eastern 120 miles crosses a rough, undrained lake district with much brush and timber and with few roads or trails. The main problem in the eastern part was to obtain as short and straight a line as possible without crossing any lakes; while in the western 80 miles it was necessary to miss villages, farms, schools, and similar buildings, orchards and valuable bush and generally avoid damaging property.

The only maps available were township maps and the standard government topographical maps, 3.95 miles to the inch. These maps were not believed to be sufficiently reliable as to details, and in fact cases were found later where lakes are one half mile from their map location and what was shown on the maps as lakes turned out to be swamps. Also certain roads shown on the plans did not exist at all and sometimes the most direct roads as shown on the map were really quite indirect.

Under these conditions it was apparent that running a location through this country which would avoid the lakes and other obstructions by ordinary surveying methods would be a very slow and tedious matter, largely one of trial and error, requiring in the first instance a general triangulation with traverses to locate obstructions, and running of trial lines. It was believed that an aerial survey would be both cheaper and quicker and at the same time give assurance of the best possible location of the lines, and a contract was made with the Aerial Survey Company to make the necessary survey.

The company was given a copy of the government topographical map showing the projected center line from Ottawa to Toronto on which they were to take two sets of oblique photographs, one from either side. The reason for taking these was the possibility that other lines in this territory might be considered, also detailed information covering the wide strip of country was necessary to decide where the logical location of the first line should be. After these oblique photographs had been taken, a final location of the line was made and vertical photographs taken over this final location.

A study of these photographs resulted in making many small changes in the line and in one difficult section it was necessary for the location engineer of the commission to fly over that section of the land.

The vertical photographs were taken at a height of approximately 6,000 feet and were made into matched mosaics in strips about 22 inches long, showing in great detail a strip of country averaging about 1¼ miles wide; the scale being approximately 1000 feet to the inch.

These matched vertical mosaics show clearly, and in great detail a strip of country each side of the final center line. Lakes, forests, cultivated and uncultivated land, buildings, fences, orchards and wooded lots are clearly discernible, as are lot lines, railroads, highways, roads, trails, rocks, and rivers. It is possible to discern small hilltops, ridges and gullies, to count trees in orchards and even discern drainage furrows and windrows. By the use of these maps, the commission's right-of-way agents were able to secure options or easements for right-of-way without any preliminary field work, showing to the various owners the location of the proposed line without going out and tramping over the fields. The only work for the field parties was the location of the line on the ground as indicated on the photograph, the runing of a profile along the center line, noting property ties and ownership of land passed over, and staking out the tower sites. The vertical photographs were of the greatest value in speeding up this necessary field work, as well defined objects in the photographs were easily located on the western section as a means of tying in the line, and the general topography, lakes, rivers, trails, barren spots, thick brush, etc., served the same purpose on the more difficult eastern end. It was found possible to run tangents up to nine miles long which have checked within a few feet.

Another valuable feature of the photographs is that they provide a detailed, accurate, permanent and easily accessible record of what is on the ground. They will be of the greatest value during the period of construction, enabling the distribution of material to be worked out to the best advantage, which is itself quite a problem in this isolated bush country where transportation costs mount up to a considerable figure. It is also expected that construction camps and material dumps can be located to the best advantage from these maps.

The same problem outlined here, and the same solution, of course are applicable to location of other than power lines; as for instance pipe lines, highways or railroads. It would appear that the greatest advantages would accrue when dealing with country which has not been surveyed and which contains few roads, trails, water ways or other means of access, or in which the undergrowth is so thick as to require expensive and tedious clearing to permit survey parties to run lines through it and make topography offsets therefrom.

Standard Traffic Ordinance and Code

Progress in work of National Conference on Street and Highway Safety and American Engineering Council in drafting a model ordinance.

By W. B. Powell

The lack of standardization in rules and devices for traffic control in the cities of the United States has become so obviously troublesome that everybody is conscious of it, yet it has been truly said that Mark Twain's famous remark about the weather can be applied to this situation also—that everybody discusses it and nobody ever does anything about it. Of course, the real fact is that this result comes from the multiplicity of controlling authorities so that there is practically no one who *can* "do anything about it," no matter how much they may be disposed so to do.

The one person who probably has more far-reaching influence in such a matter than anyone else is Secretary of Commerce Hoover, who, with characteristic energy, has undertaken to do something about it, and as a result there have been held two National Conferences on Street and Highway Safety. The outcome of these two conferences has been the production of a group of Model State Laws covering the traffic problem as it relates to highways in general, which laws are now well on the way to general enactment by most of the states in the Union.

At the second of these National Conferences, the diversity of local rules in cities was emphasized to such an extent that American Engineering Council, which is the national organization representing the engineering profession in public affairs, volunteered to make a study with the avowed object of producing a standard code for traffic signs, signals and markings for municipal use—a project which was enthusiastically indorsed by the conference. As a result, very comprehensive plans were made for a survey of existing conditions and particularly of

past experience in all of the larger cities, and in typical cities of smaller size, so that a fair cross section of the entire practice of the country could be obtained.

Unlike most questionnaire campaigns, these questions were not sent out broadcast, but first a very careful selection of local committees was made to see that the answers would be intelligently given from an engineering standpoint so that the results when tabulated would have a real comparative value. The study was conducted during the spring and summer of the current year, and as a result the committee in charge has now completed a tabulation for over a hundred cities in the United States, including all of the larger ones. The resultant report, which will take the form of a code of standard practice, will probably be completed early in 1928 and will be promulgated under the authority of American Engineering Standards Committee, as well as American Engineering Council.

Meanwhile, early in the year 1927, Secretary Hoover felt that the work of the National Conference should be carried one step beyond the uniform state law by the drafting of a model city ordinance for traffic control, and he accordingly formed a special committee to undertake this larger work. In order to avoid any duplication of effort, the American Engineering Council committee on signs, signals and markings was enlisted bodily as a sub-committee on that particular phase of the subject under the general committee on uniform ordinance.

Several meetings of this general committee have been held during the current year and far-reaching studies have been made of the traffic ordinances of the cities of the country and particularly the ordinances of those few states where there has already been an attempt made to set up standard municipal ordinances within the State, the notable instances being Michigan, California and Colorado.

The work of drafting this model ordinance is now well advanced so that there is reason to expect that it will be ready for final adoption and promulgation early in 1928. It is, therefore, quite probable that sometime in the spring of 1928 there will be called a third National Conference on Street and Highway Safety, the particular purpose of which will be to consider and adopt both the uniform traffic ordinance for cities and also the standard code of traffic practice with regard to signs, signals and markings, both of which will have the indorsement not only of the National Conference but also of the various standardizing organizations that have been working in this particular field.

Judging by the success which has come to the uniform state law that was presented by the previous National Conference, it is fair to expect that a similar history will follow as regards these two efforts of standardization in cities. While the situation is very much more difficult because of the great number of cities affected, nevertheless, the public interest in this matter is so great that it is quite reasonable to expect that when a few of the important cities have been induced to adopt the standards, the rest will be forced to follow the example through the weight of public opinion.

The Aulon Viaduct, Memphis

Construction of a concrete viaduct with approaches, totaling nearly three thousand feet, over three sets of railroad tracks. Slab instead of girder and beam construction.

By W. G. Stromquist

The elimination of dangerous grade crossings has been an important feature of the program of civic improvements in Memphis, Tennessee, during the eight-year administration of Mayor Rowlett Paine. These have been the McLemore Avenue viaduct, over the Illinois Central and Yazoo and Mississippi Valley Railroads; and the Bellevue subway under two groups of tracks, one the Union Railway and the joint tracks of the Louisville and Nashville, Chattanooga and St. Louis; the other the Southern and Frisco Railways. These improvements have greatly facilitated traffic and reduced accidents. The Aulon viaduct now under construction will eliminate another inconvenient and dangerous grade crossing.

(It is worthy of mention that of the four city commissioners who have directed these improvements, the commissioner of streets, bridges, and sewers, H. N. Howe, and the commissioner of fire and police, T. H. Allen, are engineers.)

The Aulon viaduct will carry Poplar avenue over three sets of tracks: the Union Railway; the Louisville & Nashville and the Illinois Central Railroads; and the Nashville, Chattanooga & St. Louis Railroad. Poplar avenue is one of the main highways entering Memphis from the east and carries a great amount of traffic. The Union Railway, a subsidiary of the Missouri Pacific Railway, is a belt freight line which encircles the city. The Illinois Central tracks are those of a freight line over which all through north and south freight is routed around the city of Memphis, from the Nonconnah yards south of the city and connecting with the main line at Woodstock a few miles north of Memphis. The other two railroads carry both freight and passenger trains. The interchanges of tracks at this point complicate the problem. (For the general layout of this project see Figure 1.)

The topography and the established railroad grades favored a viaduct here rather than a subway.

Preparatory to the construction of the viaduct, the corporate limits of this city were extended by an act of the state legislature in 1925 so that all the property concerned would be inside the city. It has been necessary to purchase property to pro-

vide sufficient width for the viaduct and to provide for surface roadways at the side of the structure to serve adjoining properties.

At the west end a roadway will be provided along the south side to the Union Railway. At the east end a 16-foot gravelled roadway with a concrete curb and gutter will be built along the south side of the viaduct to the N. C. & St. L. Railroad, to serve the property on that side.

Scott avenue enters Poplar avenue from the north, just east of the N. C. & St. L. crossing. This has been relocated with an approach and viaduct connecting with the main viaduct just west of the

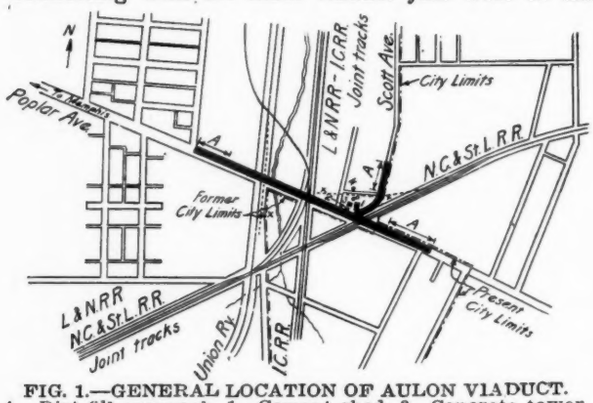


FIG. 1.—GENERAL LOCATION OF AULON VIADUCT.
A—Dirt fill approach. 1—Cement shed. 2—Concrete tower. 3—Concrete mixer under aggregate hoppers. 4—Sand storage. 5—Rock storage. X—Material yards. - - - Temporary spurs for delivering materials. Each track indicated by a single line.

N. C. & St. L. crossing. The change was made in order to eliminate an additional crossing over these tracks and was possible because most of the traffic on Scott avenue is in or out of the city rather than east on Poplar.

The total length of the viaduct and approaches on Poplar avenue will be 2320 feet, with an approach and viaduct on Scott avenue 610 feet long—a total of 2930 feet. The approaches will be built in embankment; the west approach 300 feet long, the east approach 441 feet, and the Scott avenue approach 290 feet. On the south side of the east and west embankments, reinforced concrete retaining walls will be required, 171 feet long on the west and 285 feet long on the east approach. The balance of the earth fills will have a slope of 1½ to 1 with berms 3 ft. 6 in. wide. Reinforced concrete abutments are to join the embankments with the main structure.

The viaduct provides a 36-foot roadway with a 6-foot sidewalk on the north side of Poplar avenue and on the west side of Scott avenue. An ornamental reinforced concrete rail about 3 ft. 6 in. high provided with ornamental light standards will add considerably to the attractive appearance of the finished structure. The roadway will have an asphalt surface 3 inches thick with a concrete gutter 2 feet wide at each side.

The grades will be as follows:

	Per cent
West approach	1.45
West approach to Union Ry.	3.50
Union Ry. to L. & N. and I. C. R. R.	1.20
L. & N. and I. C. R. R. to N. C. & St. L. R. R.	0.60
N. C. & St. L. R. R. to east approach	2.90
East approach	0.50
Scott avenue approach	4.00
Scott avenue viaduct	0.50

Vertical curves are used at all changes of grade.

An interesting feature in the design of this viaduct is that a reinforced concrete column and slab construction is used instead of the more usual girder and beam construction. This type of design made possible a lower height of the structure and is said to make a considerable reduction in cost.

The standard panels are 28.28 feet long with the outside or curb columns spaced 28.28 feet to center both ways and a center row of columns staggered midway between these. This spacing is to be varied near the railroad crossings; and across the Union Railway and N. C. & St. L. Railroad heavy concrete reinforced slab construction, and across the L. & N. Railroad and I. C. Railroad a plate and girder structure covered with gunite, will be used. Expansion joints will be provided at every other panel.

The subsoil consists of red clay and the foundation will consist of column footings, with special footings for the bents which support the special construction over the various tracks. The footings are 1′6″ thick, with a base varying from 5′6″ square to 7′6″ square. There will be 181 individual column footings, and 6 combined footings each carrying two columns, a total of 193 columns. The columns vary in height from 10 to 30 feet, exclusive of pedestals which vary from 1′6″ to 8′6″.

The footings will be reinforced horizontally with ½″ round hooked bars and vertically with a ⅝″ bar at each corner extending up through the pedestal. The reinforcing of the pedestals consists of ½″ round hoops and 6′ dowels to match the vertical bars in the columns. The columns, which are 2′2″

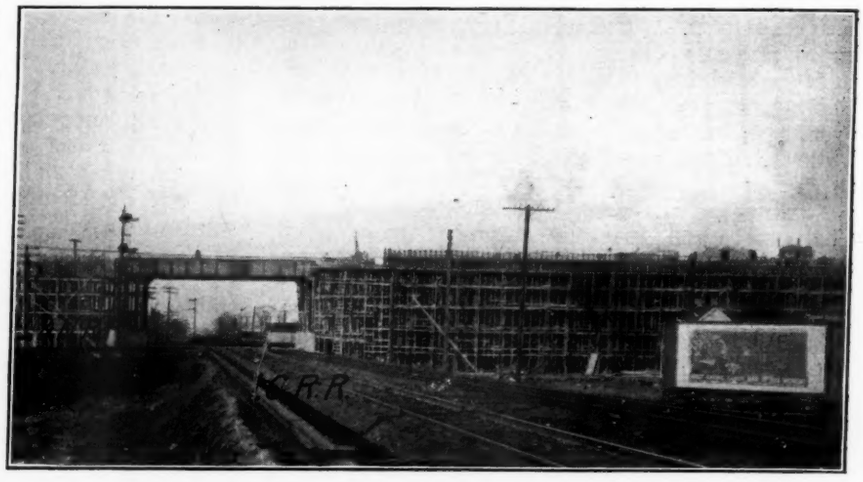


FIG. 2.—FORMS ERECTED FOR AULON VIADUCT. LONG STEEL SPAN IN PLACE.

In spite of passing of more than 100 trains a day, steel span was erected with only 14-minute delay of one train.

in diameter, are reinforced with spiral reinforcing of ⅜" wire with 3" pitch and 22" outside diameter, and eight vertical ⅞" round bars in the columns on the sidewalk side and ¾" round in other columns. Columns 30 feet high will be 2'6" in diameter.

The standard panels are 28.28 feet long from center to center of curb columns with a center column and reinforced concrete floor slab 10½" thick. Details of this reinforcing are given in the following table:

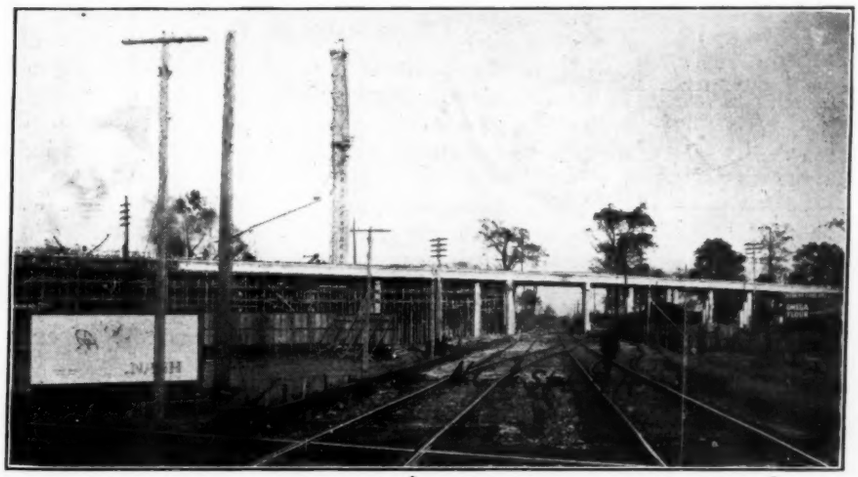
Bill of Bars in One Standard Panel
28.28 Lin. Ft. of Deck Slab

Band	*No.*	*Size**	*Length*	*Description*
Band along south curb	5	⅞"	45'-0"	Bent bars
	2	⅞"	30'-0"	Straight bars
	2	⅞"	24'-0"	" "
	2	⅞"	18'-0"	" "
	2	¾"	24'-0"	" "
Band along north curb	Same bars as along south curb			
Band along center line of structure	11	¾"	45'-0"	Bent bars
	10	¾"	25'-0"	Straight bars
	10	¾"	24'-0"	" "
Main transverse band	12	¾"	40'-0"	Bent bars
	11	¾"	24'-0"	Straight bars
Two intermediate trans. bands, each	9	⅝"	16'-0"	Hooked bars
Two diagonal bands—each	22	⅝"	Varies	Bent bars
	10	⅝"	36'-0"	" "
	10	⅝"	40'-0"	Straight bars
Girder at south curb	3	1"	46'-0"	Bent bars
	1	⅞"	30'-0"	Straight bars
	2	⅞"	27'-0"	" "
	1	⅝"	30'-0"	" "
	1	⅝"	12'-0"	" "
	23	½"	4 strand	Stirrups
Girder and sidewalk at north curb	3	1"	46'-0"	Bent bars
	1	1"	30'-0"	Straight bars
	2	1"	27'-0"	" "
	2	⅝"	30'-0"	" "
	2	⅝"	12'-0"	" "
	57	⅝"	11'-0"	Bent bars
	23	½"	4 strand	Stirrups

*All bars are round.

At the crossing over the Union Railway and over the N. C. and St. L. Railroad, bents of six columns on special footings will carry a reinforced concrete slab 32" thick. The reinforcing will consist of top and bottom bars both ways, with stirrups parallel to the bents, and with hooked diagonal bars to brace the column to the slab. The spans from center to center of columns are 34 feet at the Union Railway and 32'6½" at the N. C. and St. L. Railroad. Neither of these railroads crosses Poplar avenue at right angles.

Since the L. & N. and I. C. tracks join a short distance north of Poplar avenue, a skew structure must be provided over them. This will have four plate girders built up of ⅜" by 54" web plates, cross-braced at the ends and at two intermediate points, and supported by steel columns. The girders vary in length from 55' 4⅝" to 63' 7⅜". The floor slab will be supported on transverse 15" 60.8 lb. I-beams spaced 10 feet apart. In order to conform in appearance with the rest of the structure, the structural steel will be covered with gunite. The clearance from top of rail to bottom of girders will be 22 feet at all tracks.



PART OF VIADUCT COMPLETED. FORMS REMOVED FROM RIGHT END. Concrete being poured east of L. & N. and I. C. crossing and forms being built west of same.

It has been necessary to relocate some of the water mains and sanitary sewers preparatory to building the sidewalk. Drainage on the viaduct will be provided for by twelve inlets on the main structure and three on the Scott avenue. On the main structure the storm water will be carried in cast-iron pipes attached to the columns.

The ornamental rail will be added after the floor slab has been completed. In building this, the circular openings through the rail will be made with sheet metal forms and

for making the circular depressions around these openings and the smaller triangular depressions special cast iron forms attached to the wood forms will be used. The sidewalk brackets are precast and attached to the main structure by stirrups before the concrete of the sidewalk is poured.

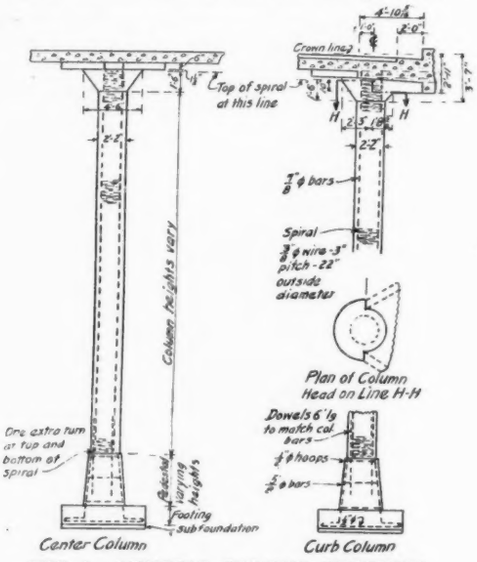


FIG. 3.—TYPICAL COLUMN SECTIONS.

The construction plant is located on the north side of the viaduct between the Scott avenue approach and the Illinois Central tracks, with concrete mixing plant and tower. The concrete is delivered with chutes as far as possible and then with concrete buggies. The contractor plans that, as the work extends west of the Louisville and Nashville tracks, dump trucks will be used to carry the concrete.

The following basic data were used in the design of the viaduct:

Loading: four lanes of traffic comprising three 20-ton trucks preceded and followed by a uniform load of 800 lbs. per sq. in. Impact and distribution as prescribed for Class A highway bridges in Appendix D, Vol. 25 of Proceedings of Am. Ry. Eng. Assn.

Stresses: reinforcing steel in tension—18,000 lbs. per sq. in.; concrete in flexure—800 lbs. per sq. in.; structural steel in flexure 18,000 lbs. per sq. in.; compression, bond, shear and other stresses and details as prescribed by "Joint Committee" as of August 14, 1924.

Concrete stresses: in open viaduct structure between abutments a minimum ultimate crushing strength of 2,400 lbs. per sq. in. at 28 days; in all other, 2000 lbs. per sq. in.

Soil pressure: under dead load—2800 lbs. per sq. ft.; under dead load and live load—4000 lbs. per sq. ft.

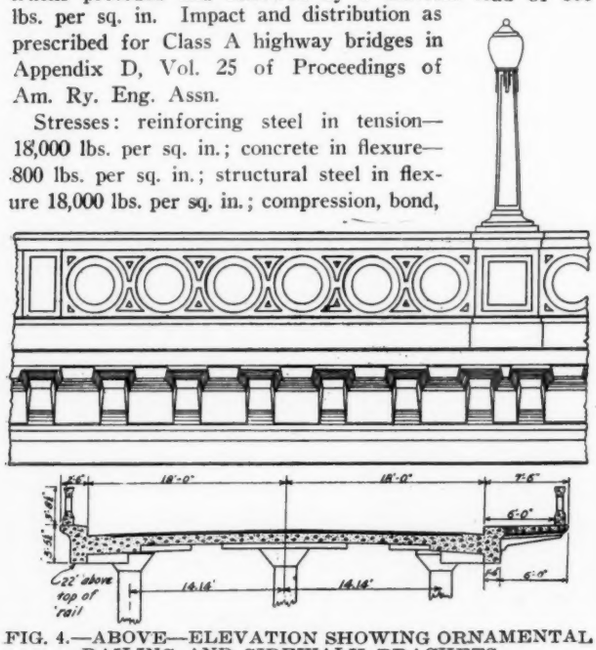


FIG. 4.—ABOVE—ELEVATION SHOWING ORNAMENTAL RAILING AND SIDEWALK BRACKETS. BELOW—CROSS-SECTION OF VIADUCT FLOOR.

The fill for the approaches will require about 7700 cubic yards of material. Other materials required are approximately 8,000 cubic yards of 1:2:4 concrete, 475 tons of reinforcing steel and 60 tons of structural steel.

The total cost of the structure, including property damage and right of way, will be about $375,000. The main contract for the structure, exclusive of lighting, paving of approaches, and side roadways, is about $242,000.

Work on this contract was started August 15, 1927, at the east approach, and is to be completed January 15, 1928. At that time the aproaches will not be paved but it is expected that the viaduct can be opened for traffic. The cost of the viaduct will be divided equally between the four railroads concerned and the city of Memphis. The work is under the direction of a board of control composed of the following: R. M. Dozier, president Union Railway; A. F. Blaess, chief engineer Illinois Central Rairoad; C. H. Brodback, division engineer N. C. & St. L. Railway; A. B. Scates, division superintendent L. & N. Railway; and W. B. Fowler, city engineer, City of Memphis. W. F. Schulz of Memphis is consulting engineer for the Board of Control and the structure was designed in his office by F. A. Busse, George W. Foster, and H. G. Overholz. I. G. Norton of the same organization is resident engineer during construction. The Gauger-Korsmo Construction Company of Memphis is the contractor, with Joe Westin as superintendent of construction.

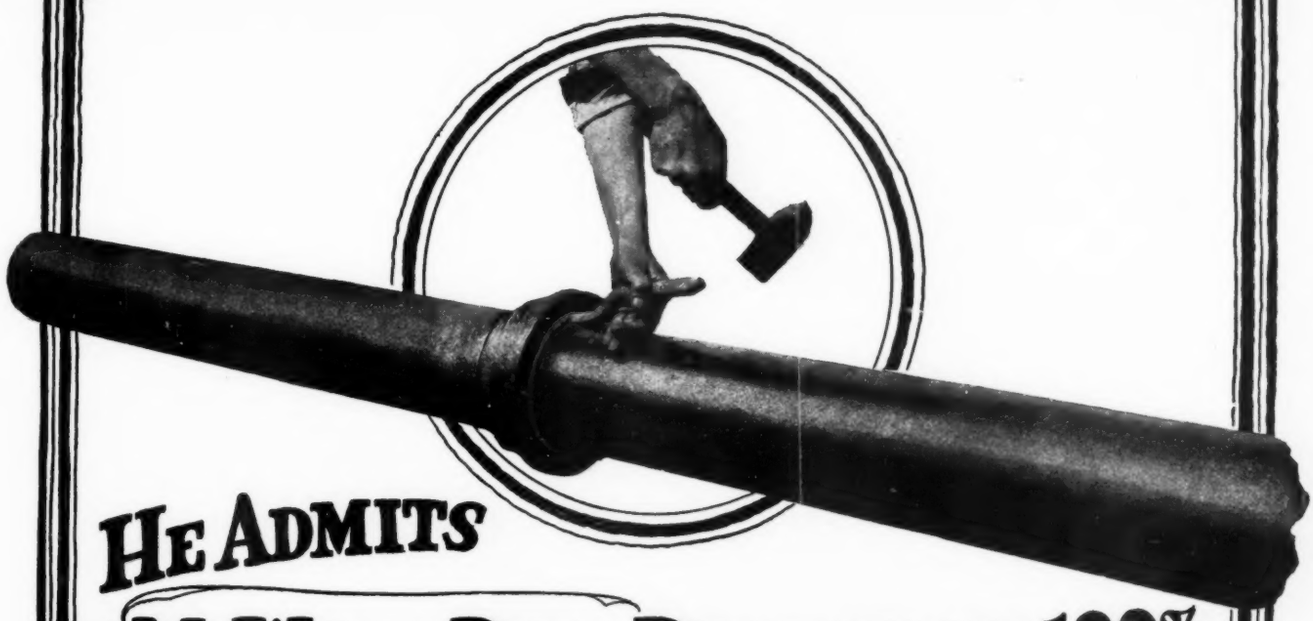
Instruction for Sewage Plant Operators

The second annual "Short Course for Sewage Plant Operators" in New Jersey is to be held on January 16 to 27, 1928, at Rutgers University, New Brunswick, N. J., under direction of the College of Engineering, in co-operation with the New Jersey Sewage Works Association and the State Department of Health.

The purpose is primarily to offer intensive training in the fundamentals of sewage disposal and sewage plant operation; also to enable plant operators to increase their general knowledge of the subject and to qualify themselves to solve their individual problems.

In Course I there will be lectures and recitations on the elements of design and construction and details of operation, by Prof. Lendall; and laboratory exercises covering principles of chemistry and biology of sewage treatment, by Prof. van der Meulen. Course II comprises comparison of design of existing plants with operation data, by Prof. Lendall; and a continuation of Course I, with more detailed study, by Dr. Rudolfs. Course III, by Dr. Rudolfs, is for those wishing to study some special problem.

The expenses for the two weeks' course, including inspection trips and incidentals, total $15, plus room and board, which need not exceed $30.



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THE writer of the letter opposite is talking about some McWane Precalked Joint Cast Iron Pipe that has just been laid by a stockholder of a competing Pipe Company. This competitor was fair—but critical!

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Dorrco Doings in 1927

THE year just closed has been one of tightening competition with lesser margins in most lines, and a disappointment to many in the total business done. In Europe it has seen the formation of an international chemical cartel as the result of the apparent success of the steel combination and a general preparation for intensive work with a lessening of uneconomic competition and a pooling of knowledge and experience in certain lines.

Although during most of the year a note of uncertainty was heard, the stock market showed confidence in the future and at the close of the year pointed towards prosperity in 1928.

Our own year has been one of better coordination with many minor advances made and several major developments that should make their contributions to the industries which we serve during the coming year. As our work has developed in different fields it has sometimes seemed as if we were spreading "too thin," and would have difficulty in really grasping the problems to be met in so many varied industries. Experience has shown, however, that our real opportunities have been greater because of it. A recent advance in Sanitary Engineering, for instance, was made possible by the use of our specialized knowledge gained in metallurgical work.

—•—

SERVICE—The service work of the Company, including supervision of installation, inspection, initial operation, and adjustment of our equipment, as well as the "trouble shooting" that inevitably arises from time to time, has now been centralized in a Service Division of our Engineering Department. This means complete coordination from the placing of the order until the new equipment is finally adjusted and running smoothly, and the operators are well trained.

THE DORRCO FILTER—As a result of a careful study extending over more than a year, we have introduced a new and distinctive type of continuous rotary vacuum filter for general filtration work. Certain features of this machine give it a somewhat broader field of utility than is generally assigned to vacuum filtration of finely divided solids.

CLOSED CIRCUIT GRINDING—Finer grinding generally required by selective flotation has called for improvment in grinding efficiency and has resulted in higher circulating loads and larger classifying units. At one plant 42 Model C Classifiers which have served well for ten years, are being replaced by new, very heavy type Model D's. Closed Circuit Grinding in primary as well as secondary circuits keeps advancing, with the Bowl Classifier in greater demand, and one cyanide mill doing all its agitation before final overflow.

The great progress made in automatic regulation of complicated manufacturing processes has made automatic feed regulation for closed circuit grinding appear an easy step. We have been working at it for a long time and believe we have now developed a control that will regulate conditions of feed or product and give the greatest grinding efficiency under widely varying conditions.

BEET SUGAR—Research and development work over several seasons has enabled us to perfect a process for making first carbonation automatically continuous and giving a controlled product of uniform quick-settling and filtering properties.

THE DORRCO SAND WASHER—The "age of concrete" has required enormous quantities of sand and gravel, produced to rigid specifications. Our contribution has been the Dorrco Sand Washer used on dredges and stationary plants and washing as much as 150 tons of sand per hour.

THE LIMIT!—When we built a Dorr Thickener 200′ in diameter some years ago it seemed very large. We have built many since, but this year our friends of the Miami Copper, where records in other lines have also been broken, have asked us to build a 325′ Thickener to dewater 16,000 tons of tailings per day. Our engineering Department say they will go further if asked.

SANITARY ENGINEERING—Sewage Treatment continues to make rapid progress, hastened by the realization that continuous mechanical operations can replace batch treatment and hand labor.

The Dorrco Bar Screen is now being installed at the world's largest sewage plant in Chicago — another unit operation mechanicalized.

An investigation covering the past year has resulted in the development of equipment for the continuous removal of clean grit or fine sand from sewage, before treatment. This avoids the periodical interruption of operation of grit chambers for the removal of accumulated solids.

Our new Square Traction Clarifier is being widely installed for sedimentation in both sewage and water works. After thorough experimentation it was adopted by St. Louis to remove the silt from Missouri River water both before and after treatment with chemicals. Four 150′ units are now under construction.

Separate sludge digestion has been adopted for the majority of installations contracted for in 1927. One of the largest plants of this type, put into operation this year at Sioux Falls, S. D., includes Dorr Clarifiers and the new type of Dorr Digester, which utilizes the gas generated by digestion to maintain the optimum temperature for the bacterial activity desired. In warmer climates the gas is available for power and lighting.

Our new Impeller Agitator, for thorough but gentle mixing to assist in floc formation, saved 45.5% of the chemicals required in one water treatment plant.

FOREIGN—We have in our New York office a four-foot globe and we take great pride in its varicolored pins showing installations all over the world in different industries. Our European associates have added many during the past year. They represent, among others, causticizing in the biggest paper mill in Europe, metallurgy in the Polish mine operated so well by Anaconda, chemical plants in Germany, sewage treatment in France and Germany, while a red pin stands for the biggest leaching plant in Africa.

Our Mr Spicer is headed for Australia and the East. When he made the same trip in 1911 it meant that one-fifth of the staff had gone.

—•—

Time has brought many changes but we feel that the best it has given us is those friends scattered over the mining camps of the world, and in more recent years through industrial plants as well, who have helped us by kindly criticisms and suggestions to develop our work. It might interest them to know that our statistician claims that over 95% of the gold and silver, over 90% of the lead and copper, 85% of the zinc and 100% of the aluminum produced in North America comes into contact with our equipment.

We cannot see the future, but if a loyal body of workers means anything, I can assure our friends that we shall go forward as in the past, proud of what we can contribute to the world of industry.

John V. N. Dorr

247 Park Avenue New York City

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CONTENTS

The Counties' Road Building Job

Fairly good progress has been made by the states, working in conjunction with the Federal Government, toward building a main system of trunk line roads; yet when completed these will constitute only 7 or 8 per cent of the entire mileage of our highways. The Federal Aid System embraces about 185,000 miles, of which about 70 per cent is now improved; state systems, exclusive of Federal Aid, do not total more than 100,000 miles. There remains the task of constructing a network of secondary and feeder roads, if the maximum benefit is to be obtained from the arterial roads now built or building.

Counties and other local governmental units are faced with the task of organizing for a major program of road construction. These roads may not be of concrete or other costly material, but their importance in the life and trade of the nation is sufficiently great to require a high degree of engineering skill in their planning and construction.

County highway engineers are increasing in numbers, as counties recognize their economy; and they are improving in quality. For nearly fifteen years, PUBLIC WORKS has been collecting information from county highway workers, and the reports received from them from year to year show a marked and steady growth in the character of men engaged in this work. The formation of a County Division of the American Road Builders Association is not only proof and recognition of this but also an earnest of even greater advancement in the future.

Interest and Depreciation Also Are Costs

The data regarding cost of trenching which will be found on another page of this issue are of twofold interest. The primary appeal to the contractor and city engineer lies in the fact that even when all possible items of cost are included, machine ditching is far cheaper than hand work. The costs given, which include all items, are probably not greater than one-third or one-fourth of the cost of hand work.

It will be seen from the table accompanying the article that the cost of operating the machine, as determined by the construction of about eight miles of trench 24 inches wide, in sand and hardpan, and in depths up to six feet, was 3.2 cents per foot, which cost included operator, gas, oil, truck time, labor, and moving the machine, this latter item accounting for nearly one-third this total. But depreciation, maintenance and interest on the investment exceeded all other costs, amounting to about 4 cents a foot, giving a total cost of operation of 7.2 cents.

In estimating cost of work in which he intends to use machines, the contractor should bear in mind such items as these, or he will have the balance on the wrong side of the ledger when the job is completed.

Stream Pollution

The streams of this country will never grow larger, nor will they increase in capacity to absorb organic wastes. Yet the volume of wastes, both municipal and industrial, discharged into them is growing larger every year, and this

increasing load of pollution interferes with the use of water for domestic and industrial purposes, recreation, fishing, and even power.

Bigger and better sewage treatment plants, and more of them, will help, provided city officials recognize the necessity of proper operation after construction; but municipal wastes, though important, are but a part of the problem. Research in industrial wastes to devise economical methods of treatment that will not burden industry too heavily are necessary. Progress in control of stream pollution in these two fields should go hand in hand.

No state can afford to place its industries at a disadvantage with like industries in other states. No program that does not take this fact into account can hope to succeed.

Sanitary Engineering Advice Is Needed

The past year has been plentifully sprinkled with disasters. The Mississippi and New England floods, tornadoes, hurricanes, and explosions have been prominent in the news.

Sanitation and the prevention of disease have been important phases of the relief activities in all these. For this work, no one is better qualified than the trained sanitary engineer, yet he is consulted but little. Engineers were conspicuous by the absence of any official standing in Florida relief work; they were called tardily and reluctantly to aid in the problems created by the Mississippi overflows; and the same is generally true of the other emergencies.

So far as we know, the Red Cross, the official agency for relief in disaster and emergency, is without permanent and capable sanitary engineering counsel. This should not be. The sanitary engineering section of the American Public Health Association, or some other agency representative of the engineering profession and familiar with this field of work, should take steps to provide adequate and flexible engineering service in such emergencies. An advisory council composed of leading sanitary and public health engineers might be formed. Such an organization could formulate policies and give advice in regard to sanitary engineering practices under the emergency conditions that are liable to arise. A reserve of capable sanitary engineers, available for emergency work, might well be created, and made familiar with the practicable policies adapted to such conditions.

Federal-Aid Highway Work

During the fiscal year ending June 30, 1927, 8,306 miles of Federal-aid highways was built. This brought the total of such highways to 64,209.7 miles, of which 56,740.7 has been built during the past six years. The complete Federal-aid program comprises 185,772 miles, so that only a little more than a third has been completed. The Bureau of Public Roads also has constructed 453 miles of main highways in the National Forests.

Federal payments for the year amounted to $81,371,013; and the total of such payments since 1916 has been $544,884,912 and the total cost of Federal-aid highways has been $1,234,173,188, the states having paid the other $689,288,276.

There were also completed during the year bridges with a combined length of 45.9 miles, bringing the total bridge construction to 167.6 miles. One of last year's bridges, over the Choctawhatchee in Florida, is more than 2 miles long; and two are more than a mile long, one in Indiana and the other in Nebraska.

The largest disbursements during the year were made to Missouri, New York and Texas. To each of these States the Federal Government paid more than $4,000,000. Pennsylvania received more than $3,000,000 and all other States less than that sum.

In proportion to the total mileage of the several geographic divisions, the Federal-aid disbursement in 1927 was greatest in the Middle Atlantic States and least in the West South Central States. On this basis the first of these groups received more than twice as much as the second, and between these two extremes the other areas, ranked in descending order, were as follows: New England, South Atlantic, Pacific, East North Central, East South Central, West North Central and Mountain.

That the offer of Federal aid has not induced the States to make expenditures in excess of those they would otherwise have made is indicated by the fact that in 1926 every State, with two exceptions only (Montana and North Dakota) made expenditures, some very large, in addition to those for Federal-aid roads, the total of such additional expenditures being $452,798,000, or more than four times the amount spent to match Federal aid.

Cooperating with the States, the bureau completed the selection of the principal transcontinental roads which will form the United States highway system, and on which uniform signs and markers are to be erected by the States. It also practically completed the distribution to State highway departments of the surplus war material, and retains only a comparatively small quantity of explosives which will be distributed this year.

The above facts and figures were furnished by Thos. H. MacDonald, Chief of the Bureau of Public Roads, in his annual report made public last month. He believes that equalling, if not transcending, in value the service directly rendered in the construction of roads, the researches of the bureau have made available to engineers more exact knowledge of the fundamentals of highway design and economics. Of special importance are the studies of the magnitude and effects of the impact of heavy motor trucks upon highway surfaces, and the possibility of reducing the intensity of the impact forces by changes in the spring, wheel, and tire equipment, and by refinement in the surfaces of roads. Other important studies dealt with soils and road surfaces, transport and traffic surveys, efficiency studies in the operations of road building, and the testing of materials and designs.

New Trouble for Illinois Contractors

Ruts are almost certain to form in earth shoulders along the edges of concrete or other hard pavement, and rain water from the pavement to flow in these and wash them deeper and at the same time soften

the shoulders. Engineers of the Illinois State highways have been trying to find a remedy that will permit the use of the shoulder for emergency traffic and be inexpensive. In recent work they have provided a "lip curb"—a low, rounded curb 3 inches high and 6 inches wide at the base along each edge of the concrete pavement, to be placed before the slab concrete has taken initial set. The construction looks simple, but it has caused the contractors lots of trouble, according to "Public Construction News," the official organ of the Illinois Association of Highway and Municipal Contractors, which says:

During the summer no construction difficulties were experienced except that some balance had to be reached between removal of laitance and time of initial set. Engineers are rightfully insistent on the removal of laitance in an effort to reduce surface scaling. This operation, if unduly continued, limits the time for placing the fresh concrete of the lip curb. Also sudden summer showers presented a serious problem. Rain, if long continued, may hold up concreting until the fresh pavement has become set up. Unquestionably, to be of any advantage the curb must be placed so that the completed concrete is entirely monolithic. Evidently if too long delayed, construction of this kind of curb would be undesirable. In case of work on a down grade the collected water confined by the curb will rush on to add to your misery.

No complaints have arrived of pavement rejection due to failure to complete the curb within a reasonable time limit. It seems if such is to be avoided, provision must be made by canvas coverings to permit construction in event of sudden rains. And this may not be as simple as first thought would suggest.

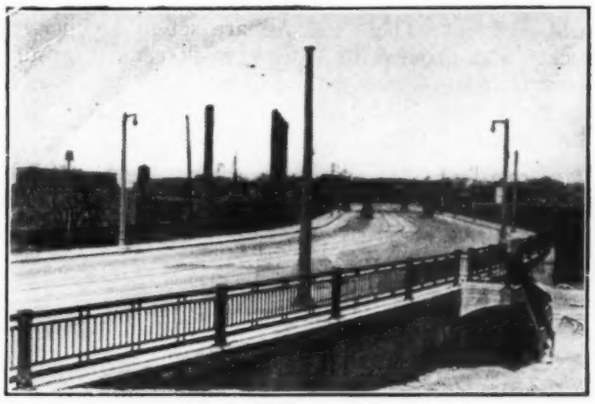
Construction during the fall months of October and November was much more complicated. The cool, moist weather retarded setting. After the end of the construction day, hours must elapse before the concrete could be finished to satisfaction. We know of instances where workmen returned after supper to work until midnight and later. The men who found these conditions were no novices either. They had years of experience and competent organization.

This curb has raised the shoulder a corresponding amount. As yet there is no uniformity in design; in that respect contractors have been required to make the necessary changes in shoulders without any change in earthwork quantities. No doubt this condition will be corrected in the future.

We are inclined to think contractors will be careless in preparing this item in their proposal. It appears simple, but those with experience report the complication mentioned. It will be used extensively on next year's pavements.

Lighting a Milwaukee Viaduct

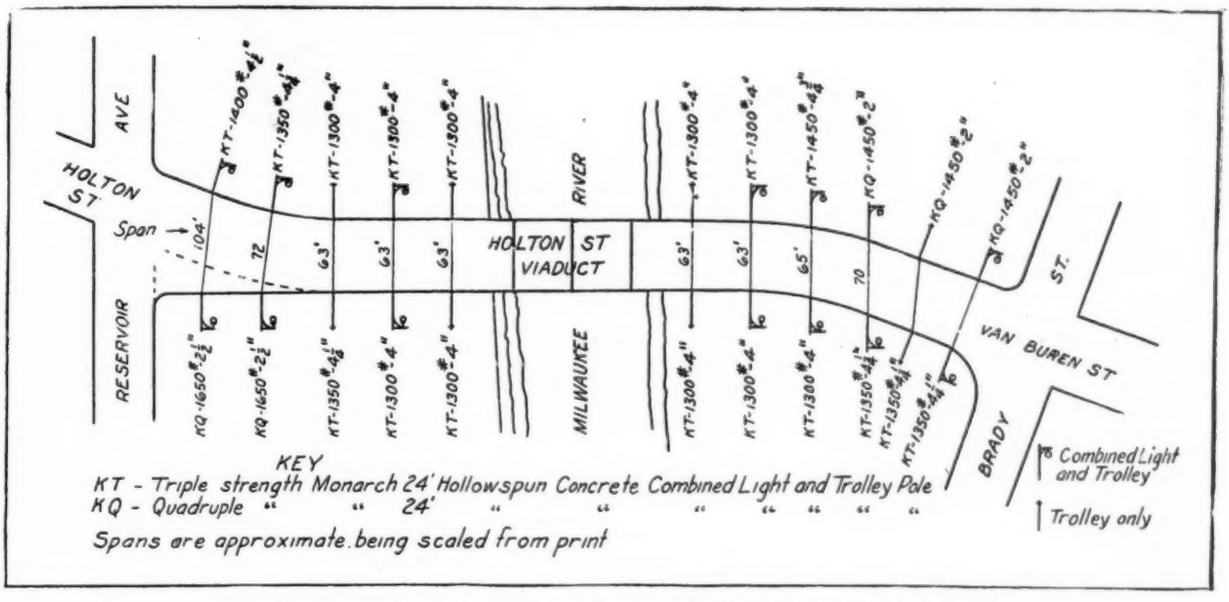
In June, 1915, G. A. Vaughn, engineer of Street Lighting Survey, recommended in his Report on Street Lighting Survey of the City of Milwaukee that concrete posts be used for all 15-foot units and that preference be given concrete poles for taller lighting units. Today, according to Martin Bruening, of the Milwaukee Bureau of Electrical Service, writing in "Concrete Highways and Public Improvements,", Milwaukee is entirely lighted from



POLES IN PLACE ON VIADUCT.

concrete lighting standards varying in height from 15 feet to 32 feet, with approximately 15,000 standards in service. Concrete standards are used not only for ornamental lighting, but for center suspension units with spans varying in length from 30 to 85 feet.

Mr. Bruening states that when the recently completed Holton Street viaduct was planned it was decided that the lighting on the bridge be kept consistent with the rest of the city. Further to improve



ARRANGEMENT OF COMBINED LIGHT AND TROLLEY POLES ON VIADUCT.

the appearance of the bridge and eliminate unsightly trolley poles, a concrete standard was designed as a combination light and trolley pole.

The type of pole chosen was an octagonal red granite with the bracket mounted 22½ feet above the ground. Both double and single brackets can be used with this type of pole. On the Holton Street viaduct a single bracket was used for the combination light and trolley pole and was erected without a bracket when used as a trolley pole only.

The poles were designed for definite loads as shown on the chart. Two of each type were tested for deflection under the designed load. The poles were then raked accordingly so that when the load was applied at the top the poles would be in a vertical position. The standards are set in a concrete socket and grouted in with a weak cement grout. This foundation method had been used previously on the Locust Street viaduct and 16th Street viaduct and had proved satisfactory.

Water Works Trenching in Seattle

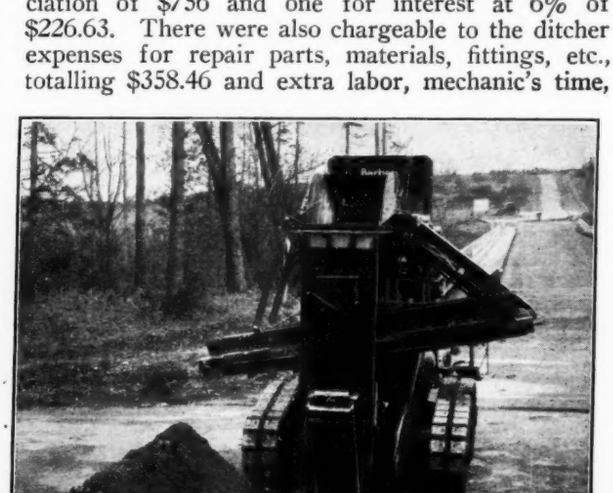
Itemized cost of excavating on fifteen jobs during the past season, using a ditching machine.

The Water Department of Seattle, Washington, bought a ditching machine in April, 1927, and put it to work on April 15. The department has compiled figures concerning the use of this ditcher during the balance of the year 1927, from which the following has been compiled.

During the season the ditcher was worked 560 hours on fifteen different jobs. The machine was not used continuously, there usually being an interval of three days to a week between the different jobs, one interval having been as long as ten weeks. The average length of ditch per job was about 2600 feet. The machine had to be moved a considerable distance from one job to another in most cases, the cost of each moving running from $22.50 to $45.00, which cost was, of course, included in the average cost per foot dug. The trenches dug varied from 2 feet to 6 feet deep, all being dug with the ditcher set for a 24-inch width. Some of the digging was in sand, but a considerable part was in hard pan where the hardness of the digging cut the progress down to an average of 558 feet a day, although in easy digging as much as 1200 feet per day was averaged on a number of the jobs.

The accompanying table shows, for each job, the number of lineal feet dug, and in most cases the depth and material; also the expenses for operators, gas, oil, time of trucks, and other labor; also for moving the machine. It can be seen that the last named cost constituted almost one-third of the total and on some of the jobs constituted over 50% of the cost of that job; being exceeded, in the season's expenses, only by the cost of the operator. The total cost for excavating 39,147 feet is seen to be $1,277.21 or an average of 3.2 cents per lineal foot.

This gives only the operating costs, and there should, of course, be included other charges, including depreciation and interest. The cost of the machine was $6,475. Estimating the life of a machine at 5 years and an average of 120 days of actual operation per year gives a charge for depreciation of $756 and one for interest at 6% of $226.63. There were also chargeable to the ditcher expenses for repair parts, materials, fittings, etc., totalling $358.46 and extra labor, mechanic's time,



SEATTLE DITCHER DIGGING THROUGH SIX-INCH BITULITHIC PAVEMENT.

Date Begun and Duration	Feet Dug	Type of Soil, Size of Ditch	Expenses: Operator	Gas	Oil	Truck Time	Other Labor	Moving Mach.	Total	Cost Per Ft.
April 15, 6 hours	1,200	34 in. deep	$6.80	$3.25	$0.36	....	....	....	$10.41	$0.008
April 19, 5 days, 4½ hours	3,657	6 ft. deep	68.00	5.85	.36	....	....	$40.00	114.21	.031
May 2, 5 days, 4 hours	5,800	Sand	37.40	19.50	.20	....	....	40.00	97.10	.016
May 11, 1 day	1,000	Sand	9.35	3.00	.40	....	....	....	12.75	.012
May 16, 1 day, 3 hours	Cross sewers*	.....	13.60	3.88	.20	....	....	....	17.68	....
July 12, 4 days, 1 hour	2,400	Hardpan 4½' deep	32.18	...	..	$15.00	....	30.00	77.18	.032
July 19, 1 day, 3 hours	1,700	Sand 2' deep	6.80	...	..	18.00	$4.11	30.00	58.91	.034
July 29, 1 day, 6 hours	1,500	4' deep	13.60	3.88	.30	15.00	5.24	30.00	68.02	.045
Aug. 2, 13 days, 3 hours	7,000	.....	90.95	24.00	.60	15.00	4.11	45.00	179.66	.025
Aug. 17, 5 days, 6 hours	3,800	.....	39.10	16.50	.60	20.00	5.50	35.00	116.70	.030
Sept. 1, 1 day 6 hours	2,000	.....	13.60	5.60	1.03	....	....	....	20.23	.010
Sept. 19, 10 days, 2 hours	2,210	.....	74.80	21.75	1.20	20.00	5.50	30.00	153.25	.069
Sept. 30, 2 days 5 hours	750	Hardpan	20.40	6.40	.30	....	....	22.50	49.60	.066
.....	1,130	.....	6.80	...	..	15.00	8.25	30.00	60.05	.053
Oct. 11, 8 days, 4 hours	4,700	Hardpan	57.80	...	.60	22.00	7.56	40.00	127.96	.027
Oct. 24, 6 days, 2½ hours	1,400	Hardpan	47.60	6.56	.65	22.50	6.19	30.00	113.50	.081
Totals and average	39,147		$538.78	$120.17	$6.80	$162.50	$46.46	$402.50	1,277.21	$0.032

*Used on cross sewers, but found impracticable on account of crossing new water main ditch. Footage not included in total, but cost charged against machine.

etc., totalling $178.60. Adding these gives a total charge against the machine of $2,796.90 and the total cost per foot of 7.2 cents.

On May 16 the machine was used in an effort to dig cross sewers but this job was found to be impracticable on account of crossing the new water main trench. The cost of this work is included in the total cost in the above estimate, although nothing is included for this work in the total footage. If the machine had been used on a continuous job of ditching, thus eliminating the cost of moving the machine and also the time involved in starting and stopping a new trench, the actual expenses probably would not have exceeded 1.8 cents per lineal foot, or 5.8 cents including interest, depreciation, repairs, etc. These costs are evidently far below that of hand labor on similar work. The machine used on this job was a Barber-Greene ditcher.

Maintaining Sheet Asphalt in Buffalo

Repairing so as to prevent formation of holes. Records used for determining economic life of pavements. When repaving becomes economical. Cost of repairs per square yard.

The methods and results of maintaining sheet asphalt pavements in Buffalo, New York, during the past 49 years were described by George F. Fisk, first assistant engineer of the Department of Public Works of that city, in a paper before the Sixth Annual Paving Conference.

The total amount of sheet asphalt laid in Buffalo up to January 1, 1926, was 8,445,789 square yards, the original cost of which was $26,624,-451. Of this there is now in existence 1,230,204 square yards laid prior to 1897 and 2,100,720 square yards laid prior to 1907. About 2,700,000 square yards was laid between the years 1889 and 1894, during a real estate boom. Of the total amount, 6,066,121 square yards have been released from guaranty, and 2,379,648 are still under guaranty. Since 1898 all pavements have been laid under a ten-year guaranty; before that time most of them were under a five-year guaranty with a few six and eight-year.

Most of this pavement was laid on 6-inch concrete base, but since January, 1926, 8-inch Portland cement concrete base has been the minimum used on all streets and 9-inches and even 10-inches under those carrying extremely heavy traffic. Approximately 30,000 square yards was laid on bituminous base between the years 1878 and 1881. At one time considerable sheet asphalt was laid over common Medina stone pavement on a sand base, but this did not prove satisfactory under heavy traffic and the method has been discontinued. Most of the early sheet asphalt pavements were laid with a ½-inch cushion but since 1892 1½-inch open binder has been used. The top course has usually been 2 inches thick.

In making repairs, the following considerations govern, when appropriations warrant. "A hole left as such for a time grows rapidly with traffic. If the pavement be old and hard, the impact against the far edge of the hole rapidly crumbles the adjoining material. If the pavement be in a more plastic condition, the dropping of wheels into such depression thins out the top around the near edge, requiring a large cut-back to reach a reasonable thickness for a repair joint. On the far side of the hole the wheel impact shifts the material forward, forming a ridge, and wheels dropping into this ridge form a depression beyond, which in time produces another and smaller ridge. This action continued produces a series of ridges and depression or waviness, which must be removed for proper repairs. Similarly, any ridge or depression tends to extend the wavy condition and is undesirable. These conditions have led to the policy of preventing rather than filling holes. In marking for repairs, the intent is to remove any surface which is in such a condition as to produce a hole before the probable date of the next repair and to remove troublesome ridges or depressions. While not possible to entirely accomplish the desired results, yet the results obtained fully warrant the continuance of the policy.

"The removal of surfaces showing indications of early failure but in an apparent serviceable condition to the casual observer, has led to some criticisms of unnecessary repairs, but it has also eliminated the old complaint of failure of repairs where they were not carried back far enough to reach sound material for a joint."

During the year ending December 31, 1926, Buffalo maintained 3,315,555 square yards of sheet asphalt pavement at a cost of 12.4c per square yard. The cost per ton for asphalt surface was $8.10 and for binder $6.70, weighed at the contractor's plant and delivered on the street. The labor cost per square yard on areas repaired was 95c, which includes the marking out of the repair and cutting out the same to the base; the removal from the street of all old material; the painting of joints; the placing and rolling of new material, and cleaning up after the repair has been completed. The cost of asphalt repairs from 1889 to December, 1925, in ten year periods, taken from the city records is as follows:

Year	Yards Maintained	Cost per Sq. yd.
Five years ending 1889....	28,445	$0.0159
Ten years ending 1899....	1,749,131	0.0466
Ten years ending 1909....	1,885,478	0.1101
Ten years ending 1919....	2,424,426	0.1113
Six years ending 1925....	2,553,414	0.1583

"The average cost of repairs on sheet asphalt maintained is 6.13c per square yard for 88,634,812 yard-years of maintenance. The average life or age of sheet asphalt pavement out of guaranty laid in Buffalo between the years 1878 and 1915 and without street railway tracks is 24.39 years.

The average age of asphalt pavements without street railway tracks replaced from 1892 to 1925 is 24.97 years. The average age of pavement replaced 1921 to 1925 is 31.71 years. The average age of asphalt pavement maintained is 24.95 years."

The city's maintenance record begins the day the pavement is released from guaranty, and from that time until the street is repaved it keeps an accurate cost of repairs as well as the location of same. These records are invaluable as they are used in determining the economic life of the pavement and permit analyzing at any time the cost of repairs to date.

"In determining the economic life of pavements we use the following formula given by H. P. Gillette in his Cost Data: 'The average first cost plus the average annual repair cost must be a minimum.' Or in other words, the first cost plus the total repairs, divided by the age of the pavement, must be a minimum. For example, we are this year repaving a street the repairs to which this year would have amounted to approximately 20c per square yard. The determination to repave was made as follows: Assuming the original cost of the top to be $1.50 per square yard, we found our total repair cost since the street was paved in 1902 amounted to $1.65 per square yard, or a total original cost plus repairs of $3.15 which, divided by the number of years service of the pavements (25), would allow a repair cost of only 12.6c.

"This rule, however, cannot be applied indiscriminately but must be used with engineering judgment. There are cases where a pavement is nearing its economic life and we find that certain localized causes have necessitated extensive repairs, while the remainder is in comparatively good shape; in such cases it is possible that an expense much exceeding the theoretical expense may place the pavement in a condition where its economic life may be prolonged.

"One of the greatest benefits resulting from our records is the fact that we are able at a moment's notice to determine the total cost of repairs to any pavement. This has a very appreciable effect on the property holder who is against having his street repaved. When we show him the total cost of repairs compared with the cost of original pavement and show him why repavement is needed, he usually goes away satisfied."

Wards Island Sewage Treatment Plant

Authorization for the employment of engineers to make a study of the proposed Wards Island Sewage treatment plan has been made by the Board of Estimate and Apportionment of New York City. George W. Fuller has been engaged as consulting engineer.

The plant, which will be designed to treat 180 million gallons daily, will cost about $16,000,000; and the cost of tunnels and intercepters will amount to about $12,500,000 additional. The activated sludge method is proposed, but final decision will be made after additional study of the problem.

Sewage from portions of Manhattan and the Bronx will be treated; later, additional sewage from the same boroughs will be brought to the plant, and possibly some from Queens.

Highways of Hillsboro County, Florida

With soft rock, sand and sand-clay the only road-making materials found in the state, stone, gravel and slag are brought from Georgia, Alabama, Tennessee and even New York.

Although materials suitable for highway paving are extremely limited both as to quantity and variety in the State of Florida, the state now contains, thanks partly to the late lamented real estate boom, about 1800 miles of paved highways, not including a considerable amount of sand-clay roads. Of this amount, Hillsboro county has 604 miles outside the city of Tampa, which contains a considerable part of the population of the county and which pays more than three-fourths of its taxes. Of these county roads, about 90 miles are of vitrified brick, approximately 200 miles are of asphalt block and sheet asphalt, and the remainder or something over 300 miles are of what is known as upward penetration.

The State of Florida has issued no bonds for road construction or maintenance, but has available a considerable sum from the 4-cent gasoline tax ($5,355,217 for the first six months of 1927) and from the automobile license fees, and this it uses for constructing a certain amount of highway, and for maintaining this and other stretches of highway taken over from the counties for maintenance. The only state-maintained highway in Hillsboro county is a part of that known as State Road No. 5. More than half of this is asphalt block which was built by the county and has been taken over by the state.

Some idea of the difficulty of obtaining materials for road construction in Florida may be obtained from the statement that the coarse aggregate used for concrete is stone obtained from Georgia and Tennessee and gravel from Alabama; and a certain amount of Hudson river trap rock obtained from New York is used also. For coarse aggregate for asphalt binder in connection with sheet asphalt pavement, the stone used is largely dolomite obtained from Georgia and Tennessee A few years ago when there was little call for phosphate, phosphate pebbles were used to a small extent for coarse aggregate. In certain kinds of pavement, slag is used which is obtained from Baltimore and Birmingham. Most of these materials are brought by water, thus obtaining cheap transportation rates. Those used in Hillsboro county are to a large extent landed at Port Tampa, on the Gulf of Mexico.

Although practically the entire state of Florida is sand on the surface and for a considerable depth, almost all of this sand is too fine for use even for mortar, and it is entirely unsuitable for paving work. Three deposits of sand suitable for this work, however, have been found near the central part of the

state, one of these being in connection with the phosphate pebbles, being washed from the pebbles in preparing them for fertilizer purposes.

In many sections of the central and western part of the state a red clay is found from five to fifteen feet below the surface, which clay is used for making sand-clay roads and also to a certain extent for making a base for a more permanent wearing surface. This so-called clay is only about 25 per cent clay and 75 per cent sand and serves very well for making sand-clay surface without the admixture of further sand.

A few years ago there began the development of a kind of lime rock found in the north-central part of the state, not far from Ocala. This rock, when mined and crushed, assumes a consistency somewhat similar to chalk. It is being used to make an excellent base for wearing surfaces. In Hillsboro county it is used almost exclusively as the base for the upward penetration surface.

In constructing this upward penetration pavement, the road is first graded, the grading throughout the county running generally between 10,000 cubic yards and 4,000 cubic yards per mile of road. The standard width of pavement is 16 feet and the width including earth shoulders on each side is 30 feet, while the right-of-way is 60 feet.

After the roadbed has been graded, the lime rock is brought from the nearest railroad siding by trucks, dumped on the road bed and spread by hand or by a blade in front of a truck or tractor. For secondary roads the base is made 6 inches deep after compacting and for primary roads 8 inches deep; the depth decreasing about 30 per cent during compacting. The material is kept sprinkled all the time while being rolled, a three-wheel roller being used specified to have a weight of 300 pounds per inch width of roller. No limit is placed by the specifications on the amount of water to be used except that it must be abundant, it being believed that the contractor is not liable to use too much. In fact, after a heavy rainstorm the uncompacted lime rock has been found to have almost the consistency of a thick mortar, but when partially dried and rolled it has been found to be in excellent condition. When rolled, this lime rock base presents a surface as smooth as a floor and can be used as a wearing surface directly, but it abrades very quickly and is not often so used for more than a few weeks before a protecting wearing surface is placed upon it.

After the base has been rolled, a priming coat of oil is applied at the rate of one quarter gallon per square yard, this oil containing 45 per cent asphalt, 100 penetration; the purpose of this being to fill the pores of the base, which is quite porous, although the oil does not penetrate to a depth of more than about a quarter of an inch. This is allowed to stand for two weeks, more or less, under traffic. Then "macadam binder" asphalt, at the rate of 0.4 gallon per square yard, is applied, immediately followed by a course of slag at the rate of 40 pounds per square yard; this slag being graded between one-quarter-inch and three-quarter-inch. This slag is spread as thinly as possible while at the same time completely covering the road and is then rolled with a tandem roller, which produces a wearing surface with a thickness of about three-eighths of an inch.

Owing to the thin layer of slag used, excessive rolling is not necessary but it is considered sufficient if each square foot of the surface is gone over twice. If the asphalt has been properly applied, this will give a uniform surface with no free asphalt showing; but if asphalt or slag have been applied non-uniformly, it may be necessary to add additional slag at some places to take up the surplus asphalt. Traffic is turned on to the pavement immediately. Piles of additional slag are left at intervals along the road and where ever asphalt shows upon the surface a small amount of slag is spread over it by shovel by the maintenance patrol.

In fact, maintenance immediate and continuous is necessary for securing the proper service and life of this pavement. Should the lime rock base begin to show through the wearing surface at any point, it is necessary to immediately patch it with asphalt and slag; otherwise the base itself would wear rapidly under abrasion and impact and pot-holes be formed which would enlarge rapidly under traffic.

The cost of the lime rock base is about 90c. per square yard for a six-inch base. The surface costs about 25c. to 30c. per square yard. Practically no equipment is used in the construction other than that mentioned, namely, trucks, shovels, pipe and hose for applying water, a heavy roller for rolling the base and a tandem roller for rolling the surface. The equipment of the maintenance patrol consists of a one-ton truck drawing behind it an asphalt kettle mounted on rubber-tired wheels so that it can be transported from point to point at considerable velocity; the truck carrying shovel and pick, a quantity of slag and of asphalt.

One of the difficulties of keeping roads in Florida in proper condition is the flat topography and the existence of ground water within a short distance of the surface which prevail over a large part of the state. It is found desirable to keep the ground water level at least two feet below the surface of the road (some maintain that four feet is necessary), both by building up the road itself and by excavating ditches along the side of the road. In the flat districts it is common to see water standing in the side ditches not more than two or three feet below the level of the road, this being the case this fall, although the rainfall in Hillsboro county up to December first was 18 inches less than the normal rainfall.

The cost of the county roads is paid entirely by the county, which obtains the necessary funds by issuing bonds. A considerable part of the population included within the metropolitan district of Tampa lies outside of the city limits and is unincorporated, and the paving of streets in this territory is done under county supervision. This is paid for by the abutting owners through the medium of certificates of indebtedness which are issued by the county and are given to the contractors in payment for the road. There are also provisions for the organization of road districts, which can raise funds by issuing bonds in the same manner as a county. In general 30 year bonds are issued and are paid for by an ad valorem tax.

The county engineer of Hillsboro county is A. B. Pimm, and to him we are indebted for most of the above information.

Recent Legal Decisions

COMPENSATION FOR RELAYING PAVEMENT

Where the facts showed substantial performance of a state highway paving contract, the contractor was held entitled to reimbursement for the expense of relaying such portion as was required by the highway department. Each such case must be determined on its own particular facts.—Chambers v. State, New York Court of Claims, 128 Misc. 227, 218 N. Y. Supp. 375.

EVIDENCE OF REASONABLE CHARGE FOR HAULING SAND AND GRAVEL

In an action on a contract or, in the alternative, on quantum meruit, for hauling sand and gravel for road construction, it was held that the jury were entitled to take into consideration the weight and character of the materials hauled, the weight, and not the volume, being the first consideration. The plaintiff was held properly permitted to testify as to what he had received for hauling similar materials on similar jobs before, on the issue of what was a reasonable charge for such service.—Brown & Root v. Hausenfluck, Texas Court of Civil Appeals, 293 S. W. 842.

COUNTY'S LIABILITY FOR VALUE OF LAND TAKEN FOR ROAD WITHOUT CONDEMNATION

Where a State highway commission, in the construction of a road, took a strip of land without the owner's knowledge or consent, and the county, without acquiring and paying for the land, accepted and used the road, the county was held liable to the owner for the market value of the land taken and for damages to the remainder, under Kentucky Const. §13, providing that property cannot be taken for public use without just compensation, and Ky. Stab. §4356t7, providing for the acquiring of rights of way for highway purposes by condemnation or agreement.

EVIDENCE OF VALUE FOR GRADING WORK DONE AFTER DISCOVERY THAT WRITTEN CONTRACT WAS BASED ON MISTAKEN ESTIMATE

In an action on quantum meruit by a subcontractor against a principal contractor for excavating and grading, evidence of the actual cost of the work was admissible as bearing upon the reasonable value of the work. Though not incontestable evidence thereof, it was an important particular in arriving at the reasonable value.

The oral contract was made after the discovery during the work that the original written contract was based on an error in estimating the rock to be excavated and the yardage to be removed. Evidence of proposals made by other firms for the work prior to the awarding of the contract to the plaintiff were held inadmissible, these being based on conditions different from those encountered by plaintiff, and on prices per cubic yard based on approximately 12,000 cubic yards to be excavated, whereas the plaintiff, because of the unexpected conditions encountered, excavated only 3,985 cubic yards.—A. P. Nolan Grading & Construction Co. v. Schilling, (Mo. App.) 293 S. W. 79.

RIGHT TO EQUIPMENT AND MATERIAL UNDER ROAD CONTRACT PROVIDING FOR ITS TAKING OVER AFTER CONTRACTOR'S DEFAULT

A road construction contract provided that, if the contractor failed to carry out its provisions, the board of county commissioners could take over its completion and also the equipment and material on the project and use these in completing the contract. The contractor defaulted and after due notice the equipment and material were taken over by the board and used in the completion of the contract. The agent who supervised the work, and who was acquainted with the contract provisions, claimed to have purchased and to own the machinery and equipment, and he brought an action of conversion against the board for the value thereof. The Kansas Supreme Court held, Duncan v. Clary, 254 Pac. 386, that the contract was a valid one, that it gave the board a contractual lien on the machinery and equipment which was enforceable in equity, not only against the contractor but also against his agent, who purchased the property with notice of the contract provision.

Certain of the machinery and equipment, which was found to have been sold and not merely rented to the contractor after the contract was executed, in the knowledge of the seller that it was to be used under the contract, was also held to be subject to the contractual lien.

RELATIONSHIP'S OF ROAD CONTRACTORS CREATED BY SUBLETTING AGREEMENT

M. Bros., a contracting firm which had secured a contract to construct part of a State highway, made an agreement with G. another contracting firm which had previously worked under M. Bros., using its own grading outfit, that G. should furnish this outfit and oversee the work and divide the profits. At this time G. had sold the outfit to another party, D. On the completion of the work D. sued both contractors for the use of the outfit. G. did not answer and judgment was entered against that firm by default. M. Bros., however, was held not liable, the relationship between M. Bros. and G. being held that of contractor and subcontractor, and not that of joint adventurers.—Dunn v. Gilbert, Wyoming Supreme Court, 254 Pac. 121.

ASSUMPTION OF DEBTS ON ASSIGNMENT OF ROAD SUBCONTRACT

A road construction contractor sublet, a portion of the work, and the subcontractor in turn sublet a portion of his work. The second subcontractor employed a steam shovel engineer with the use of a truck. Subsequently the second subcontractor sold his interest in the job to the first subcontractor, who by written agreement assumed the outstanding obligations. In an action by the engineer against the first subcontractor, the Alabama Supreme Court

held, Liles v. Cox, 110 So. 716, that, as a creditor of the second subcontractor, the plaintiff could claim the benefit of that agreement and sue the first subcontractor in his own name.

Evidence that on the execution of the agreement the second subcontractor showed the first subcontractor a list of his indebtedness on which the plaintiff's claim did not appear was held inadmissible as contradicting the written agreement. Evidence tending to show the amount due the plaintiff on the road project was held admissible.

ARBRITRATION CLAUSE IN STATE HIGHWAY CONTRACT VALID AND ENFORCEABLE

A road construction contract contained a provision that any dispute should be referred to the State highway commissioner or the Attorney General or First Deputy Attorney General of Pennsylvania. The contractor claimed that this arbitration clause was invalid and did not prevent it from applying directly, under the Act of March 30, 1811, to the auditor general and State treasurer for adjustment of its claim. It was held that such an arbitration clause is valid in a contract with the State, as in contracts with municipalities and individuals; and the fact that an officer of the State was agreed upon as the arbiter did not alter the rule, unless it were shown that he arbitrarily refused to act, or did so capriciously or fraudulently. There is no express enactment of the Pennsylvania legislature that such provisions shall be inserted in highway contracts, though they have been used from the first of the road-building agreements. To insert such a clause is within the implied power of the commissioner of highways under the Sproul Act of 1911. The court said: "When contracts are let, the contractor knows the terms by which he will be bound, and any clause deemed essential, relative to the work in hand, may be incorporated, and an arbitration clause is certainly within reason, and is usually found where municipal work is to be done, so as to avoid possible litigation. Unless restrained by some positive enactment, the stipulation for arbitration was properly included in its agreement. Smith v. Wilkinsburg Borough, 172 Pa. 122. Commonwealth v. Eastern Paving Co., 288 Pa. 571, 136 Atl. 853.

ROAD CONTRACTOR NOT LIABLE FOR INJURY FROM CORNERSTONE PLACED BY OTHERS

A road contractor was held not liable for wrongful death caused by a wagon striking a raised unlighted cornerstone of a highway at night where the stone was placed as a marker by an employee of the county surveyor and not by the contractor as part of his duties under his contract. Mahoney v. Sharp (Ind. App.) 156 N. E. 566.

REPAIR OF ROAD UNDER MAINTENANCE PROVISION OF SUBCONTRACT

A bond to secure a road contractor's obligation to keep the road in repair for a year, to terminate 12 months after a certain date, does not fix a prescriptive period for bringing action on the bond, but only limits the period of suretyship to one year.

Notice to the surety of the contractor's default in repairing the road which affords it an opportunity to inspect the road and make necessary repairs, is sufficient. More formal notice, if required, would be waived by the surety's knowledge of the default and its conduct in showing the intention not to repair.

The principal contractor may recover for repair of a road under the maintenance provision of the subcontract, where the principal has undertaken the work of repair for account of the subcontractor. —Reynolds v. Bonner, 162 La. 562, 110 So. 756.

ROAD CONTRACTOR'S BOND DOES NOT COVER PLANT AND EQUIPMENT

The Mississippi Supreme Court holds, United States Fidelity & Guaranty Co. v. Yazoo County, 110 So. 780, that Miss. Laws 1918, c. 217, sec. 1, requiring a contractor's bond for highway construction to be conditioned for payment of material used in the work and giving those furnishing such material right of action on the bond, is for the protection of those furnishing materials which enter into and become a permanent part of the improvement, or are naturally and necessarily consumed in the course of the work, and is not intended to protect those furnishing contractor's plant and camp equipment or material necesary to keep such equipment on an efficient basis.

PUBLIC WORKS CONTRACTOR'S BOND MAY COVER ORDINARY REPAIRS ON EQUIPMENT

Although a public works contractor's bond does not cover machinery and equipment used by the contractor in carrying on the work, or repairs to such machinery or equipment, the Circuit Court of Appeals, Fourth circuit, holds, Maryland Casualty Co. v. Ohio River Gravel Co., 20 Fed. (2nd) 514, that there are repairs of an incidental and inexpensive character which do not in any true sense add to the value of the equipment, but are incidental to the carrying on of the work and represent merely ordinary wear and tear or its equivalent. The labor of a mechanic who keeps in repair and running condition a fleet of trucks used on the job adds to and becomes a part of the finished structure just as truly as does the labor of one who wields a pick or shovel and it makes no difference where the work of repair is done.

FINAL SETTLEMENT FIXING TIME FOR ACTION ON GOVERNMENT CONTRACTOR'S BOND

"Final Settlement," as used in the statutory provision governing the time for suit on a government contractor's bond, does not mean an agreement between the contractor and the proper government official adjusting the balance due, nor does it mean payment of the balance due under the contract. It means the final determination by the proper governmental authority of the amount which the government is finally bound to pay or entitled to receive under the contracts. There may be a final settlement between the government and the contractor, so as to fix the rights of the creditors under the statute, notwithstanding the balance may be subject to change; for, when the government has clearly indicated that it has no further claim against the surety, a final settlement within the purview of the act has taken place.—United States v. Starr, 20 Fed. (2nd) 803.

ORDINANCE DISCRIMINATING IN FAVOR OF LOCAL TRADE HELD VOID

A municipal ordinance imposing a tax upon persons, firms, or corporations residing outside of the city for doing the identical thing that a resident might do without being subjected to such tax (in this case manufacturing and distributing bakery bread and other bakery products) was held to be a gross discrimination in favor of local dealers, unconstitutional and void. Campbell Baking Co. v. City of Harrisonville, Mo., 19 Fed. (2nd) 159.

ORDINANCE PRESCRIBING LICENSE FEE FOR FERRY BETWEEN STATES HELD INVALID

A village ordinance prescribing a license fee for the operation of a ferry across a river from one state to another under penalty of fine was held invalid as placing an unreasonable burden on interstate commerce in violation of the commerce clause of the federal constitution. Scott v. Village of Thebes, Dist. Ct. E. D. Illinois, 17 Fed. (2nd) 410.

ORDINANCE REQUIRING LICENSES OF MOTORBUSSES VALID ALTHOUGH INCIDENTALLY AFFECTING INTERSTATE COMMERCE

An ordinance of the city of Philadelphia requiring passenger motorbusses to be registered and licensed, although affecting busses doing an exclusively intrastate business, with routes through the city streets and terminals within its limits, is not an unconstitutional imposition of a burden on operators of motorbusses carrying on an interstate business, the ordinance incidentally affecting interstate commerce. American Transit Co. v. City of Philadelphia, 18 Fed. (2nd) 991.

NEW JERSEY STOP NOTICE PROVISION NOT MANDATORY

The provision of section 5 of the New Jersey Lien Act of 1918 relating to payment to the principal contractor of money impounded by stop notices, upon giving bond, etc., is not mandatory on the municipality, but discretionary. The statute says such funds "may be released and paid to the said contractor." Linker v. Board of Education of Borough of Collingswood, New Jersey Supreme Court, 132 Atl. 84.

LIABILITY OF MUNICIPALITY FOR TORTS OF ITS AGENTS

The Illinois Appellate Court, First District, holds, Bedtke v. City of Chicago, 240 Ill. App. 493, that, in Illinois, cleaning a city alley by collecting the refuse and debris and burning it, as was done in this case, (1) was for a local purpose and did not constitute an exercise of police power, and further (2) is as a matter of law a ministerial function as distinguished from a governmental function, and (3) as regards the negligence of a servant doing such work, the principle of *respondet superior* applies, and the city was held liable for the damages suffered by an owner whose property was destroyed by fire by the negligent use of a portable incinerator in an alley back of his premises, resulting in the destruction of his tools, appliances fixtures and merchandise. The court is of opinion that a municipal corporation, "like any other principal, should be liable for the torts of its agents, and the distinction between governmental and ministerial functions, used in determining the liability of a municipal corporation for negligence in affirmative conduct, should be abandoned."

GRADING CAUSING UNNECESSARY FLOODING OF PROPERTY ENJOINED

Where the proposed construction of a highway would divert the surface water from its natural course so as to flow upon the lands of adjacent owners in an unusual and unnatural manner, and it was feasible to construct the road so that this diversion would be unnecessary, the Iowa Supreme Court held, Estes v. Anderson, 213 N. W. 566, that the owners were entitled to an injunction to prevent this manner of grading.

"PREVAILING RATE OF WAGES" ON PUBLIC WORKS UNDER NEW YORK LAW

Section 220 of the New York Labor Law, requiring municipalities to pay laborers, workmen and mechanics on public works the prevailing rate of wages in the locality for an eight-hour day, is not unconstitutional in failing to set any definable standard by which the terms "prevailing rate" and "locality" can be determined. There are certain well-defined rules by which the question of what is the prevailing rate of wages can easily be determined. Among these "are the usual wage agreements between organizations of employers and organizations of employees in respective industries; and if a group of workmen constitute the dominating factor in the given industry, the rate fixed in such agreements could properly be called the prevailing rate."—Campbell v. City of New York, 128 Misc. 382, 219 N. Y. Supp. 131.

CONCRETE FORMS HELD COVERED BY CONTRACTOR'S BOND

Lumber furnished to the contractor for the construction of waterworks for forms for concrete was held "material furnished in the erection" of the plant, the payment for which is protected by the contractor's bond required by Michigan Compiled Laws 1915 section 14829.—People ex rel. Fox v. United States Fidelity & Deposit Co., 238 Mich. 326, 213 N. W. 68.

MUNICIPALITY'S CONTRACT TO GIVE CONTRACTOR BONDS AT PAR HELD INVALID

The Iowa Supreme Court holds, Iowa Service Co. v. City of Villisca, 213 N. W. 401, that a contract by a city council for the erection of a light and power plant, by which the council agreed to deliver to the contractor, to be applied at par on the contract price, bonds which had been offered for sale and no bids received, was illegal so far as the exchange of the bonds was concerned. "The bonds having been once offered for sale in accordance with the requirements of the statute, the treasurer had a right thereafter under the statute to sell the same at par with accrued interest, and not otherwise." Under the Iowa statutes there was no power to barter or to exchange the bonds except under section 6258 of the Code of 1924, which provides for the exchange of bonds for outstanding indebtedness. Here there was no outstanding indebtedness.

NEWS OF THE SOCIETIES

Jan. 9-10—INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS. Annual convention at Detroit, Mich.

Jan. 9-14—AMERICAN ROAD BUILDERS' ASSOCIATION. Annual convention and road show at Cleveland, O.

Jan. 19-21—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting at New York City.

Jan. 23-27—TEXAS WATER WORKS SHORT SCHOOL. Tenth annual session at Houston, Tex.

Jan. 23-27—ASSOCIATED GENERAL CONTRACTORS. Annual convention at West Baden, Ind.

Jan. 25-26 — NATIONAL PAVING BRICK MFGRS. ASSN. 22nd annual convention at Chicago, Ill.

Feb. 3 — NEW JERSEY STATE LEAGUE OF MUNICIPALITIES. Annual Meeting at Trenton, N. J.

Feb. 21-24—SOUTHWEST ROAD SHOW AND SCHOOL. Wichita, Kansas.

Feb. 28-March 1—AMERICAN CONCRETE INSTITUTE. Annual meeting at Philadelphia, Pa.

June 25-29—AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting at Atlantic City, N. J.

SHORT SCHOOL AND SOUTHWEST WATERWORKS CONVENTION

The Tenth Annual Short School and Convention of the Texas Section of the Southwest Waterworks Association will be held in Houston, Texas, at the Lamar Hotel, January 23 to 27 (inclusive), 1928.

There will be 48 papers, reports and discussions on the program of the waterworks section, covering promotion, production, distribution and purification. Sessions of this section will be held morning and afternoon, Monday, Tuesday, Wednesday and Thursday. Sewage sessions, comprising 35 papers, will be held Tuesday, Wednesday, and Thursday. The laboratory section meetings begin Monday and continue four afternoons, covering bacteriological and chemical matters, two sessions being allotted each division. A joint session of all sections will be held Friday, Jan. 27, which will include the business sessions, committee reports, and election of officers. A number of inspection trips have been arranged following the business meeting.

The meeting will be held under the joint auspices of the Texas Section, American Water Works Association, the Texas State Department of Health, and the City of Houston. W. S. Mahlie, president of the Texas Section, A. W. W. A., is director of the school, and Jas. H. B. House, general water commissioner, Houston, chairman.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS

Th Eighth Conference of this association will be held at the Hotel Statler, Detroit, Mich., Jan. 9 and 10. After the usual preliminary work and organization, a number of papers will be presented on the subjects of street cleaning, sewer and catch basin construction and maintenance, refuse collection and disposal, street excavations, and salvage. The committee appointed to study methods and costs of different garbage disposal systems will report. This Committee consists of Carl Schneider, New Orleans, E. F. Murphy, Boston, and E. C. Goodwin, New York. Papers will, in general, be confined to ten minutes, and will be followed by round table discussions.

ASPHALT PAVING CONFERENCE

The sixth annual asphalt paving conference was held at Atlanta, Ga., Nov. 28 to Dec. 1, with about 350 present. A large number of papers were presented bearing on asphalt pavement, design, construction and maintenance and asphalt technology. Thomas H. MacDonald, of the Bureau of Public Roads, outlined the size of the road problem of today, and stated the needs for a lost-cost supplemental construction capable of proper maintenance. C. N. Connor, of the Highway Research Board, discussed methods of construction for bituminous surfaces for secondary roads, considering surface treatment, "mixed-in-place" methods, and premixed materials. V. L. Ostrander suggested the use of asphalt surfaces for old concrete roads. E. N. Seymour, of the Georgia State Highway Commission, recounted the experience of Georgia regarding gravel and stone bases with asphaltic wearing surfaces. George D. Fish, of the Deparmtent of Public Works of Buffalo, discussed service records and maintenance requirements. A. R. Ebbetts, test engineer, Allegheny Co., Pa., discussed the variation in asphalt film surfaces on mineral aggregates in relation to mixture. Other papers on asphalt technology were presented by A. W. Dow, Francis P. Smith, H. W. Skidmore, R. M. Green, Julius Adler, Prevost Hubbard and F. C. Field.

BOSTON AFFILIATED TECHNICAL SOCIETIES

Nearly 300 members of The Affiliated Technical Societies of Boston and their guests were present at the morning, afternoon and evening sessions of the Welding Meeting held on December 14, 1927, by that organization. The morning session, held in Chipman Hall, Tremont Temple, was devoted principally to structural welding, with an introductory paper by F. M. Farmer, president, American Welding Society, New York, on "General Principles of the Various Welding Processes." This paper was followed by papers on "Examples of Arc-Welded Steel Construction," by Gilbert D. Fish, consulting engineer, Westinghouse Electric & Manufacturing Company, New York, and "Welding Trusses for Industrial Buildings", by Andrew Vogel, General Electric Company, Schenectady, N. Y.

The luncheon and the afternoon session, at the Boston City Club, were held jointly with the New England Water Works Association, one of the member organizations of The Affiliated Technical Societies of Boston. The program of the afternoon session, which was devoted principally to pipe welding, included the following papers:

"Pipe Line Welding from the Oxy-Acetylene Viewpoint," Le Roy Edwards, Industrial Engineering Dept., Air Reduction Sales Company, New York.

"Pipe Welding and Other Recent Developments in Welding," D. H. Deyoe, Industrial Engineering Dept., General Electric Co., Schenectady, N. Y.

"Thermit Pipe Welding," Robert L. Browne, New York and New England district sales manager, Metal & Thermit Corp., Boston, Mass.

"Replacing Castings by Steel Elements Cut to Shape by Automatic Shape Cutting Machines," Dr. A. Krebs, treasurer, General Welding & Equipment Co., Boston.

"The Metallurgy of Welding Wire," C. A. McCune, director of research, American Chain Company, Bridgeport, Conn.

At 6:30 p. m. an informal dinner and smoker was held, at which Col. Lewis E. Moore, chairman of The Affiliated Societies of Boston presided. The evening session, at The Boston City Club, included the following papers:

"Unit Stresses and Reliability as Applied to Structural Welding," Fred T. Llewellyn, representing the American Society of Civil Engineers on the Joint Structural Welding Committee.

"Applications of Projection and Multiple Welds," Thomson Electric Welding Company, Lynn, Mass.

"Reclaiming a Cast Iron Waterwheel Casing." G. W. Babcock, sales engineer, Westinghouse Electric & Mfg. Co., Boston.

"Atomic Hydrogen Welding Process," P. Alexander, Thomson Research Laboratory, General Electric Co., West Lynn, Mass.

An unusual feature of this meeting was the expeditious manner in which the twelve papers were presented, each session closing in strict accordance with the time schedule and yet allowing ample opportunity for discussion.

All aspects of welding were covered by the papers, including a description of the various welding processes and actual applications to typical jobs.

An exhibit was held at The City Club, in connection with this meeting, which included welding apparatus and specimens of welded material.

ASSOCIATED GENTRAL CONTRACTORS

W. A. Bechtel, of the W. A. Bechtel Co., San Francisco, Calif., has been nominated by the executive board of the Associated General Contractors for the presidency of that organization. The election will be held at the annual meeting, Jan. 23-27, 1928, at West Baden, Ind.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION

The 22nd annual meeting of the National Paving Brick Manufacturers Association, will be held Jan. 25 and 26 at the Edgewater Beach Hotel, Chicago. One day will be given over to a general meeting, and the other day devoted to group meetings.

PORTLAND CEMENT ASSOCIATION

The 25th annual meeting of the Portland Cement Association was held at Chicago, Nov. 14-16, with an attendance of about 400, representing 72 manufacturers.

A number of technical papers were presented, and officers elected as follows: President and chairman, G. S. Brown; vice-presidents, E. M. Young and Robert B. Henderson; treasurer, John L. Senior.

MILWAUKEE ENGINEERS' SOCIETY

At the annual meeting of the Milwaukee Engineers' Society, the following officers were elected: President, A. H. Luedicke; vice-president, Fred Doepke; secretary, Robert Cramer.

AMERICAN SOCIETY OF CIVIL ENGINEERS
IOWA SECTION

At the annual meeting of the Iowa Section, which was held at Des Moines, Nov. 17, officers were elected as follows: President, A. H. Fuller, Iowa State College; vice-preisdent, S. M. Woodward, University of Iowa; secretary, R. B. Kittredge, University of Iowa.

AMERICAN WATER WORKS ASSOCIATION, CALIFORNIA SECTION

The next meeting of the California Section will be held at San Francisco, Calif., week of June 11th, 1928, in conjunction with the annual convention of the American Water Works Association. Wm. W. Hurlbut, 207 South Broadway, Los Angeles, Calif., is secretary.

PERSONALS

T. Howard Barnes, consulting engineer of New York City, for many years engaged in work in South and Central America, died in Lima, Peru, Nov. 15.

Steven B. Story, director of the Bureau of Municipal Research, Rochester, N. Y., has been appointed city manager of that city at a salary of $20,000.

D. W. French has resigned as manager of the Hackensack Water Co., and has been appointed consulting engineer of the company.

O. C. Rollman, division engineer of the Wisconsin State Highway Department, has been appointed construction engineer to succeed F. M. Balsley, who has resigned. D. F. Culbertson has been appointed division engineer to succeed Mr. Rollman.

N. M. Isabella, maintenance engineer of the Wisconsin Highway Department, has been appointed a division engineer, and has been succeeded as maintenance engineer by J. R. McLean.

Clarence A. Crane, since 1909 secretary and general manager of the General Contractors Association of New York, died Dec. 5. He was 53 years old.

Harold A. Thomas, professor of hydraulics in the department of civil engineering at the Carnegie Institute of Technology, has been appointed hydraulic engineer for the city of Pittsburgh to make a study of flood heights as affected by various proposed changes on the water fronts, according to an announcement. His appointment was made by the Department of Public Works. His work for the city will be specifically concerned with scientific studies of flood heights in relation to re-location of bridge piers, re-location of boulevards along the rivers, and other construction changes recommended by the City Planning Commission and similar agencies.

CIVIL SERVICE EXAMINATIONS

Technical Assistant in Sanitary Engineering.—Applications to January 14. To fill vacancy in Public Health Service. Salary $2,100. Duties include public health engineering work pertaining to stream pollution, sanitary surveys, the treatment of water, sewage and industrial wastes, drainage and antimalarial measures, sanitation of milk and shellfish, and elementary chemical and bacteriological work.

BOOK REVIEWS

Municipal and Rural Sanitation. By V. M. Ehlers and E. W. Steel. 448 pp. 116 ill. McGraw, Hill Book Company, $4.

This is an excellent presentation of a broad and difficult subject, on which there have been previously few authoritative data. The book covers briefly Communicable Disease, Milk and Food Sanitation, Plumbing, Ventilation, Light, Housing, Industrial Hygiene, Tourist Camps, Swimming Pools, and Vital Statistics; and in somewhat greater detail Excreta and Sewage Disposal, Water Supply, Refuse Collection and Disposal, and Mosquito Control. Throughout extraneous matter has been omitted and the treatment is clear and sensible, evidencing the personal familiarity of the writers with most of the problems discussed. Health officers, public health workers, and sanitary engineers will benefit by reading this book.

The Principles of Sanitation. By C. H. Kibbey. 354 pp. 32 ill. F. A. Davis Co., $3.50.

In his many years as Chief Sanitary Inspector of a large industrial corporation, Mr. Kibbey has had much practical experience in sanitation, but he does not do himself full justice in this book, which is hardly more than a superficial presentation of material already available in other form. For the beginner in sanitation, or for those who wish an introduction to the field of sanitation, it is worth study; but the worker in the health field will find little that is new.

MUNICIPAL AND OTHER PUBLIC REPORTS

Quality of Water of Pecos River in Texas.—Water Supply Paper 596-D. By W. D. Collins and H. B. Rippenburg. 20 pp. Illustrated.

Great Basin of the Missouri. Water Supply Paper 566, U. S. Geological Survey, Washington. 366 pp. 50 cents. (From Superintendent of Documents, Washington, D. C.)

The Missouri River drains an area of 530,000 square miles; the discharge varies greatly from day to day, and year to year. Systematic records over a long period of years have been collected, showing extremes of daily and annual discharge at 210 gaging stations. At Leavenworth, Kansas, the farthest downstream gaging station on the river, the highest stage in July showed a flow of 344,000 second-feet; and the lowest flow in December showed only 8,400 second feet.

These reports are published annually; Water Supply paper 566 covers the year ending September 30, 1923.

Studies of the Efficiency of Water Purification Processes. Public Health Bulletin No. 172. U. S. Public Health Service, Washington, D. C. 423 pp. ill. By H.. W. Streeter, Sanitary Engineer. Part I is concerned with a presentation of the results of the preliminary study of the Cincinnati and Louisville plants in 1915 and 1916. This is followed, in part II by a detailed report of the results of the survey made in 1923-4 of the Ohio River plants. Part III recounts the results of the 1923-4 survey of plants located elsewhere than along the Ohio River. Appendices include data on daily laboratory results, and descriptions relative to the seventeen municipal water purification plants included in the 1923-4 survey.

New Map of Mississippi Flood Region. The Geological Survey has prepared a map of that part of the Mississippi basin on which the various plans for flood control might be shown. It extends from Dubuque to the Gulf and from beyond Omaha, Tulsa, and Houston on the west to Chicago, Evansville and Tuscaloosa on the east, embracing a region about 900 miles long and 600 miles wide. The scale of the map is approximately 16 miles to the inch. It may be obtained from the Geological Survey, Washington, at 50 cents a copy.

Water Resources of Great Basin. Water Supply Paper 570. U. S. Geological Survey, Washington, D. C. 180 pp. 25 cents. (From Superintendent of Documents, Washington, D. C.)

The Great Basin is not, as its name might suggest, a single pan-shaped depression gathering its waters to a common center but is divided into a large number of independent drainage areas, of which the Great Salt Lake Basin is

(Continued on page 50)

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

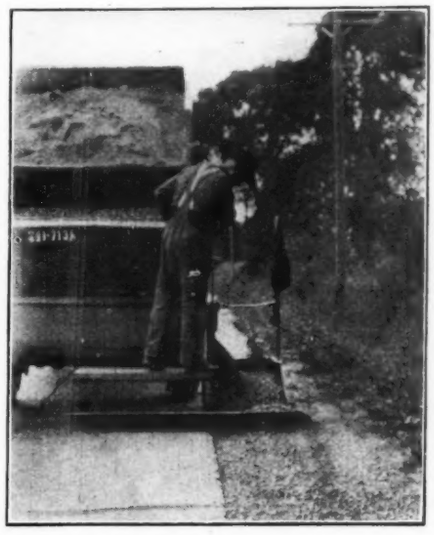
SMALL BUCKEYE SERVICE DITCHER

The Buckeye Traction Ditcher Co., Findlay, O., has added to its line the Model 150 Service Ditcher, which is a light-weight ditcher of rugged construction, extremely flexible in performance. The cutting widths are 16 to 26 inches; the cutting depth up to 8 feet. The overall width is 6 feet 6 inches; height, with boom raised for travel, 10 feet; length, 12 feet, excluding boom. Approximate weight is 9 tons. It is entirely one-man operated. It is mounted on full-length Alligator crawler wheels, giving a bearing pressure on the ground of 7 pounds per square inch. Standard cutting speeds are 12.8, 18.1, 35.7 and 66.4 inches per minute, but other gears can be furnished to provide four higher or lower speeds.

A unique feature of Model 150 is its reverse digging traction which enables it to dig while traveling backward. This permits tunneling under sidewalks or other obstructions, or removing spoil where trenches have caved. This Buckeye Service Ditcher can, therefore, dig straight down beside a wall or building, since nothing projects or is carried back of the bucket line. The crowding mechanism assures that the boom will not back away from the cutting face or rise on account of excessive traction feed.

BRABAZON SHOULDER MAINTENANCE MACHINE

The Brabazon Mfg. Co., Stoughton, Wisc., has developed a shoulder maintenance machine, which, it is claimed does away with the labor of 5 to 6 men and saves $60 to $100 per day. The maintainer is attached to the rear of the truck, making it a rigid unit, but can be detached in 15 minutes, leaving the truck free for other use. It will operate at a truck speed of 5 to 8 miles per hour, making a complete and finished shoulder in one operation. It is capable of operation within a range of ½ inch to 8 inches in depth, and 12 to 36 inches in width. The supply of materials is under perfect control of the operator, and he is able to place more or less material, as may be required by the fill on the shoulder. While placing the shoulder, the truck remains entirely on the finished roadway.



BRABAZON SHOULDER MAINTENANCE MACHINE.

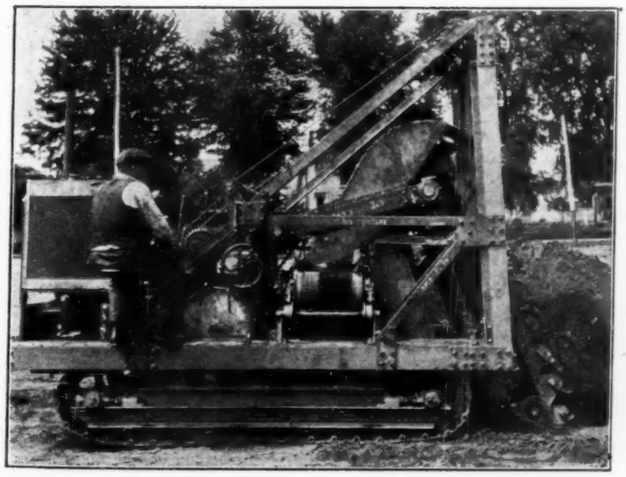
This machine has been used with satisfaction by the Wisconsin Highway Commission.

OHIO POWER SHOVEL, CRANE AND DRAGLINE

The Ohio Power Shovel Co., Lima, O., has just brought out a new one-yard shovel, crane and dragline. Gasoline, Diesel or electric drive is optional. Many radical departures from conventional design are inbuilt, chief of which are the use of Timken roller bearings instead of bronze sleeve or babbitt and a single line hoist. The use of roller bearings has reduced friction and increased speed and smoothness. Maintenance costs are cut, as the roller bearings need lubricating only every six months. Bearing adjustments are seldom if ever necessary and, with ordinary care, one set of bearings should outlast the machine. This is the first time a single line hoist has been applied to a power shovel of this size, and it automatically allows a higher lift and greater reach. Cable cost is cut to the minimum as a short sturdy wire rope, traveling very slowly, is used. Four passes a minute can be maintained indefinitely. Due to the elimination of friction by the use of roller bearings, the gasoline consumption per yard of dirt moved is very low. Three-lever control is used, the position and throw being so arranged that any steam shovel operator can get maximum yardage in a very short time. Independent control of the dipper is another feature. An all-gear propelling drive is used, with all driving gears under the truck in oil-tight cases.

THE WHITE TRACTOR HOIST

The Oklahoma Engineering and Foundry Co., Muskogee, Okla., manufactures the White tractor hoist, which is claimed to adapt the Fordson tractor to every hoisting problem. This device gives an average maximum line pull of 4,000 pounds at 150 feet per minute, but may be used at 120 feet per minute for 5,000 pounds pull. The two-speed take-off has a 10,000-pound pull at 60 feet per minute. Pull and speed can be varied by numerous sprocket changes. Among the many uses for



BUCKEYE TRACTION DITCHER

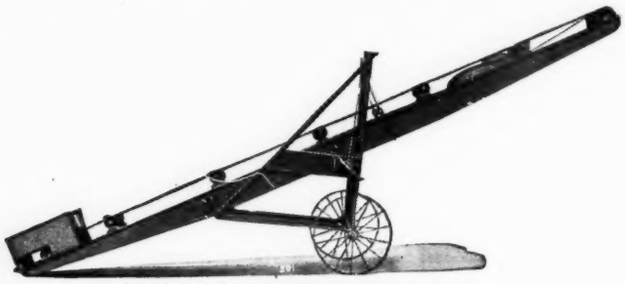
OHIO POWER SHOVEL

which this hoist is adapted are unloading pipe, pulling pavement breaking plows, handling sand and gravel, backfilling trenches, screwing up large pipe joints, erecting steel, or pulling stumps and trees, and snatch team work.

UNICON PORTABLE BELT CONVEYOR

The Stephens-Adamson Mfg. Co., Aurora, Ill., manufactures the "Unicon," a light-weight, self contained, portable belt conveyor. It handles sand, gravel, brick, bags, boxes, or anything that can be carried on an 18-inch conveyor belt.

The girder type frame is built in standard sections. The head section carries the electric motor and drive mechanism. The tail section carries the belt tightener and steel loading hopper. Intermediate sections of various lengths are used to make up the standard 15-ft., 20-ft., 25-ft. and 30-ft. Unicons.

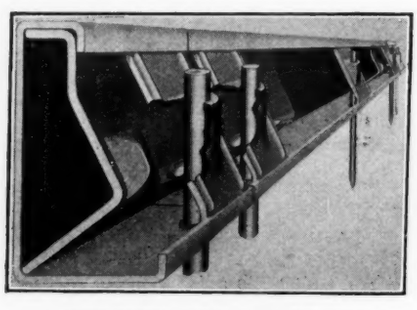


UNICON PORTABLE ELEVATOR.

The conveyor is carried in a light, rigid hoisting rig mounted on wire wheels. A worm actuated, self-locking winch raises and lowers the angle of incline, and the whole machine is so balanced that one man can readily move it. The drive mechanism and motor are enclosed. Accurately cut gears and heavy ball bearings make the drive quiet and efficient. Idler shafts, as well as head and tail shafts, are equipped with ball bearings.

NEW HELTZEL ROAD FORMS

The Heltzel Steel Form & Iron Co., Warren O., announces a new road form distinctly different in type from anything heretofore developed. It is claimed to be the most efficient and rigid form ever built, and sufficiently strong to withstand all weight and strength requirements of road machinery now in use, or probable in the next few years. The construction is heavy throughout. The joint locking arrangement locks the form, and automatically aligns the rail ends and holds them so rigidly that deflection at the rail joint is impossible. The simplicity of setting and stripping the forms is said to be unparalleled. The form is a complete unit, there being no separate parts but the two stakes.



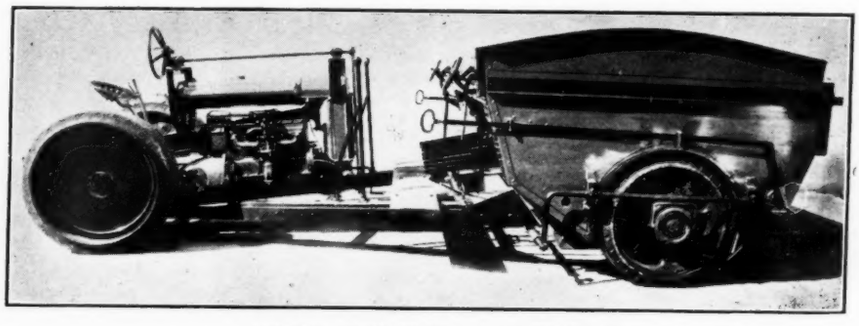
HELTZEL ROAD FORM.

BIT-U-CRETE

The Carter-Waters Corporation, Kansas City, Mo., manufactures a new paving material, known as Bit-U-Crete, which can be laid cold and requires no expensive tools or equipment. Bit-U-Crete is made under a special process and is said to be an ideal material for resurfacing old pavements and patching holes, since it is applied easily and quickly without delaying traffic. It can be laid on wet surfaces as well as on dry; in fact in patching, it is desirable to wet the hole before filling with Bit-U-Crete. This assures a good bond and eliminates creeping and rolling. The Missouri Slate Highway Department and several Kansas and Missouri cities have used Bit-U-Crete.

MOTOR AGGREGATE SPREADER

Highway Products Co., New Bedford, Mass., has just put out a motorized mechanical aggregate spreader, which is so designed that it will handle sand, pea stone, gravel, cinders, calcium chloride, and similar material, either screened or unscreened. Large particles of stone do not interfere with the even spread of smaller stone. It is possible to control both depth and width of spread, from one foot wide in any part of the machine up to 10 feet. The aggregate is spread ahead of the wheels. The bin can be recharged on the job direct from any truck that has a clearance of 37 inches. The power unit is a tractor steering from the power wheels. The machine is claimed to be able to replace 20 men, and to save 25 per cent of material as compared to hand labor.

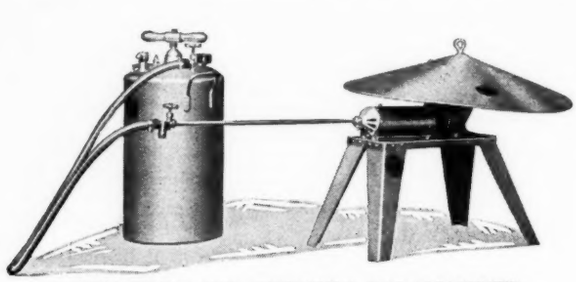


MOTOR AGGREGATE SPREADER.

LITTLEFORD OIL BURNING SALAMANDER

Littleford Bros., Cincinnati, Ohio, have recently placed on the market a salamander which is a distinct departure from anything yet offered. It uses kerosene or a light furnace oil for fuel. It is of value in increasing the comfort and efficiency of workmen in cold weather, keeping concrete and masonry from freezing, drying plaster and damp buildings, etc. The manufacturers claim it produces enough heat to replace from four to six salamanders of the coke-burning type.

It is simple to operate, being controlled entirely by a single valve adjustment. There is no smoke, ashes or sparks to contend with, nor are there any dangerous fumes. When used indoors where walls have been plastered, it will not mar them in any way, and there is no danger of a fire, as the flame is entirely contained under a hood. A special pan under the burner prevents any possibility of oil dripping on floor. Legs are made so that the salamander will not upset if bumped. and it can easily be moved from place to place. This unit is made in two sizes. Fuel consumption is about ½ gallon per hour for the No. 1 and ¾ gallon per hour for the No. 2 size.



LITTLEFORD OIL BURNING SALAMANDER.

Littleford Bros. have recently issued a bulletin, No. C-7, describing their oil-burning salamander.

LENHART TRACTOR DUMP WAGONS

The Lenhart Wagon Co., Minneapolis, Minn., manufactures the Lenhart tractor dump wagons, which, combined with McCormick-Deering tractors, make an outfit which, it is claimed, is especially economical in dirt moving, since one wagon and tractor will replace 2 to 4 teams. The Trail-It Hitch is used to join the two units, and allows short turning and easy handling. The Lenhart wagon is built of steel, complete, except for the

NEW CATALOGS

Thew Shovel Co., Lorain, O.—An elaborate 40-page illustrated catalog describing Lorain 75 shovel, crane, dragline and back digger.

Chausse Oil Burner Co., Elkhart, Ind., a 4-page illustrated folder describing Chausse Oil Burning tar kettles and torches.

Kennedy Valve Mfg. Co., Elmira, N. Y. A 24-page illustrated booklet commemorating the 50th anniversary of the company.

International Cement Corporation, New York. Bulletin No. 16, 12 pages, illustrated.

Novo Engine Co., Lansing, Mich. Illustrated folders describing the new Novo Diaphragm pumps, and the new High Speed Triplex road pump.

Jaeger Machine Co., Columbus, O. A catalog describing the new 7s "Speed Mixer."

Stephens-Adamson Mfg. Co., Aurora, Ill. A 24-page illustrated catalog describing gears, gear reducers, variable speed transmission and power equipment.

Worthington Pump and Machinery Corp., N. Y. A 28-page illuctrated catalog describing the Worthington Double-Acting, Two-Cycle Diesel Engine.

Parker Appliance Co., Cleveland, O. A 16-page illustrated catalog of Parker tube couplings for copper tube water and gas services.

La Clede-Christy Clay Products Co., St. Louis, Mo. An 8-page illustrated bulletin of La Clede-Christy fire brick and other products.

Koehring Co., Milwaukee, Wisc. An illustrated folder describing the Koehring gasoline shovel.

Lidgerwood Mfg. Co., New York. An illustrated folder describing the Lidgerwood contractors' hoists.

Koehring Co., Milwaukee, Wisc. An illustrated folder describing the Koehring heavy duty high speed paving mixer.

The Thew Shovel Co., Lorain, O. A 16-page booklet describing the advantages of the center drive principle as applied to steam shovels.

The Miami Trailer-Scraper Co., Troy, O. An illustrated folder describing the Miami bottom dump trailers for tractor use, the Miami back-filler, and the Miami one-man power scraper.

The Harrington-Seaberg Corporation, Moline, Ill. A looseleaf catalog describing a complete line of signal systems, flashers and signal and traffic controls.

R. W. Cramer & Co., Inc., New York, N. Y. Bulletins B and C, and Catalog Section 5, illustrating and describing Sauter electric time switches.

Lenhart Wagon Co., Minneapolis, Minn. 4-page illustrated folder describing Lenhart tractor dump wagons.

Ingersoll-Rand Co., New York. A 4-page illustrated folder describing the I-R portable pumps, pile drivers, safety-first air saws, and portable hoists.

Tokheim Oil Tank & Pump Co., Fort Wayne, Ind. A series of illustrated bulletins describing Tokheim traffic control signals.

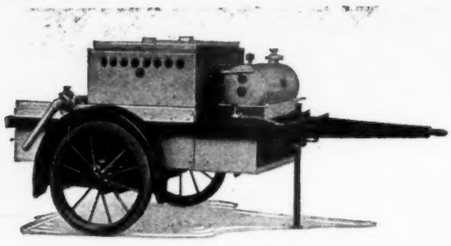
International Harvester Co., Chicago, Ill. A 16-page illustrated catalog describing motor coaches.

Wallace & Tiernan Co., Inc., Newark, N. J. An illustrated folder on Wallace & Tiernan Service in floods.

Novo Engine Co., Lansing, Mich. A 4-page illustrated folder describing the new Novo diaphragm pumps.

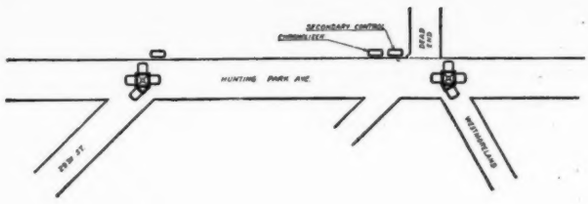
Asphalto-Concrete Corporation, New York, N. Y. An 18-page illustrated catalog describing the Billé-Ligonet and Moir-Buchanan processes of binding asphalt to concrete.

International Harvester Co., Chicago, Ill. A 32-page illustrated catalog describing International Harvester Co. heavy duty models, double reduction and chain drive.



LEFT:
LITTLEFORD
TOOL HEATER.

RIGHT:
TOKHEIM
TRAFFIC
CONTROL



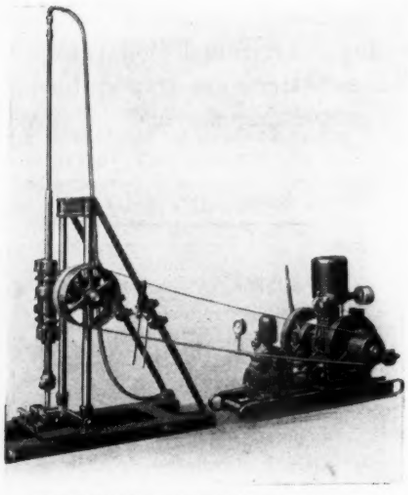
NEW LITTLEFORD TOOL HEATER

Littleford Bros., Cincinnati, Ohio, have added to their line of road and street construction and maintenance equipment, an oil burning tool heater known as their No. 90. This is really a combination tool heater and asphaltic cement kettle. The capacity of the heating compartment is more than fifteen paving tools, such as tampers, smoothers, shovels, rakes, etc., and tools properly heated for paving work can be withdrawn in less than five minutes after they have been placed in the heating compartment. The asphaltic cement kettle has a capacity of 50 gallons and makes an extra melting kettle for ordinary repair work unnecessary. The kettle will produce hot melted material ten minutes after the burners have been started. The heater is free from smoke, sparks, and ashes, making it very desirable for work in congested districts. It has high carbon steel axles with roller bearing wheels, making trailing safe. Rubber tires can be provided, the addition of which makes this tool heater a high-speed outfit. A descriptive bulletin No. C-5 telling of the many features of the No. 90 tool heater will be sent to anyone interested.

SULLIVAN "BABY TURBINAIR" AND "BRAVO 300" DRILLS

The Sullivan Machinery Co., Chicago, Ill., has announced two new diamond core drills. The "Baby Turbinair" drill is intended primarily for underground mineral prospecting where short holes are desired for blocking out ore bodies, and work of that sort. As indicated, it will drill at any angle of the 360 degrees, removing a 15-16-inch core to depths of 150 feet or less. A distinctive feature of this drill is the Sullivan turbinair motor, which produces a very smooth drilling action, thus reducing vibration and wear on the diamond bits.

The "Bravo 300" drill is used by engineers for mineral prospecting and also for engineers' test borings. The capacity of this machine, namely 50 to 200 feet in depth, and its portability and compactness adapt it particularly to test work for the sites of dams, bridges, dry docks, harbor work and to locate bed rock along the lines of tunnels, aqueducts, etc. Its adaptability to operation by either hand power, electric motor, or gasoline engine gives it a wide range of usefulness.



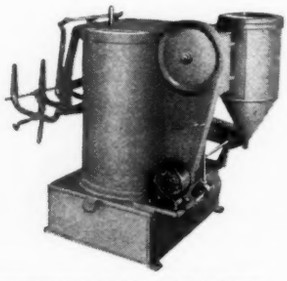
SULLIVAN TURBINAIR DRILL.

TOKHEIM TRAFFIC CONTROL

The Tokheim Oil Tank & Pump Co., Fort Wayne, Ind., manufactures a large line of automatic and manual traffic control systems for streets and highways. The Tokheim "Chronoplan" system has been developed to control traffic with maximum efficiency and to permit streets to be utilized to maximum capacity. As its name implies, it is a timed plan system, in which all traffic movements are carefully timed. Complete flexibility allows individual adjustment of the *stop, change* and *go* periods at each intersection to meet best the natural divisions of traffic. If blocks are of uneven length, or if traffic volume varies on different streets, which is the normal condition in every city, maximum efficiency of traffic movement cannot be obtained unless individual adjustment is provided at each intersection.

This desired adjustment of time relation between signals is maintained by the "Chronolizer," upon which is set up the time cycle for the system. The Chronolizer consists essentially of an automatic flasher which is so connected that alternate wires are energized during alternate periods in the cycle. The length of these periods can be varied by easily adjustable pointers. This arrangement provides the flexibility demanded to care for the changing traffic conditions.

This system has been installed in a number of cities, including Cleveland, O., Chicago, Ill., and Philadelphia, Pa.



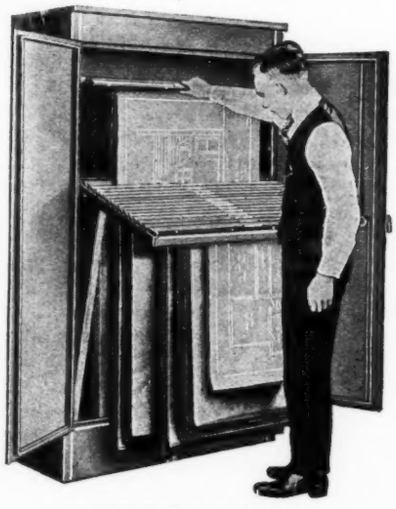
CENTURY BAG CLEANER

CENTURY BAG CLEANER.

The Century Bag Cleaner Co., Cincinnati, O., manufactures bag cleaners in two styles, either hand operated or motor driven. It is stated that about 1 per cent. of the cement originally in the bag is recovered by this process, which represents a large saving in cement; because of the disagreeable nature of hand cleaning, many bags are thrown away, with a resulting loss; the labor cost of cleaning is greatly reduced by machine work. Bags are automatically counted, and a bell rings at every fifty for bundling. Style B, which is motor-driven, is equipped with counter, exhaust fan and dust arrester, and bag baling attachment. This model is claimed to be absolutely dustless in operation, and, of course, faster in operation than the hand-operated machine.

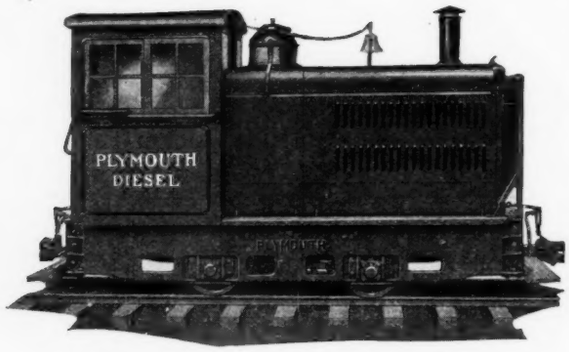
HAMILTON PLAN FILE

The Hamilton Mfg. Co., Two Rivers, Wisc., manufactures the Hamilton Calumet plan file, which is a vertical steel cabinet file of a rather new design. The



HAMILTON PLAN FILE.

GALION 10-TON TANDEM ROLLER.



PLYMOUTH DIESEL LOCOMOTIVE.

body, which is of selected hardwood, matched and glued. The body has a capacity of 2 yards with standard 8-inch flare boards. All loads are carried through springs.

DOMESTIC DEWATERING FORCE PUMPS

The Domestic Engine and Pump Co., Shippensburg, Pa., has recently introduced a new line of dewatering force pumps. These are made in both diaphragm and plunger types, and in both single and double units. Double pumps may have separate suction and discharge connections for both pumps, or with connections manifolded. The double unit pump is capable of delivering full capacity against a maximum working head of 80 feet. It will put 16,000 gallons per hour through 150 feet of 4-inch discharge line against a head of 35 feet.

RIX HOIST

The Squier-Rix Company, Milwaukee, Wisc., manufactures the Rix Hoist, which is a handy auxiliary road construction, handling steel, forms and materials and on general municipal work, placing pipe, cracking pavements, pulling stone curbs, servicing motor trucks, and on general work. The hoisting speed is 32½ r.p.m., and the hoist is designed for a working load of 2 tons. Boom heights up to 14 feet are furnished. Control is through one lever conveniently placed. These cranes are powered with Fordson, McCormick-Deering and Case tractors.

GALION 10-TON TANDEM ROLLER

The Galion Iron Works & Mfg. Co., Galion, O., has announced a 10-ton heavy duty tandem motor roller, which meets the present demands for more compression on asphalt, and for motor power instead of steam. The new roller is powered by an Hercules Model G motor. The power steering is operated

DOMESTIC FORCE PUMP.

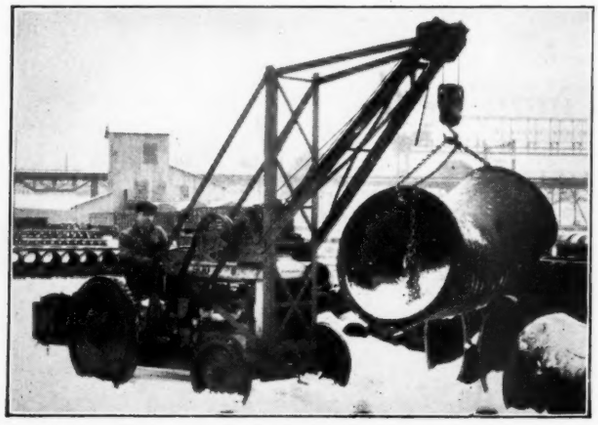
by the same motor and a special transmission designed and produced in the Galion plant meets the special requirements of tandem service on asphalt, which are smooth and quick operation, and positive reversal, as jerky operation or allowing the roller to stand still will result in an uneven asphalt surface. Reversing instantly and smoothly, without gear shift, the operation of this tandem is very quick and smooth. Thorough tests on asphalt work under strictest requirements have shown that this tandem roller fully meets the requirements. It is claimed that this roller has attained fully all the advantages of the steam tandem without the disadvantages of supplying fuel, frequent firing and smoke. The Galion line of motor and steam tandems now consists of 10, 9, 8, 7, 6 and 5-ton sizes.

PLYMOUTH DIESEL LOCOMOTIVES

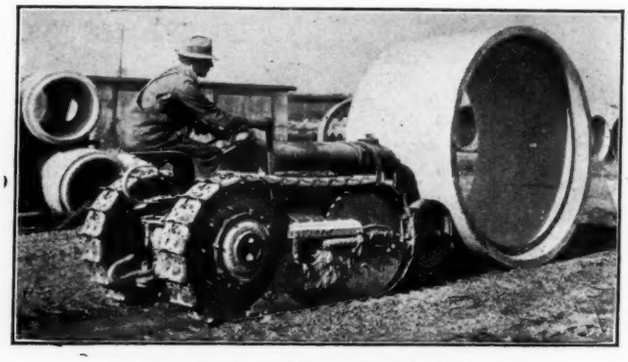
The Plymouth Locomotive Works, Plymouth, O., has just brought out what it believes to be the first Diesel-powered, gear-driven locomotive built in America. The 10 and 12-ton types are especially adapted for light track, long, heavy grades, and sharp curves, where heavier locomotives cannot be used. The power plant is a 4-cylinder, 4-cycle, enclosed type, Atlas Imperial full-Diesel engine, developing 77 horse-power. At an engine speed of 650 revolutions per minute, locomotive speeds are 2½, 4, 8¼, and 13½ miles per hour. At 2½ miles per hour, with sand, the draw-bar pull of the 10-ton is 6,666 pounds; of the 12-ton, 8,000 pounds. Any gauge is furnished from 23⅝-inch to 56½-inch.

ROLLING PIPE BY TRACTOR

The Belle City Mfg. Co., Racine, Wisc. have developed a flexible roller for the front end of the Belle City Crawler, which permits the handling of pipe by rolling. Concrete pipe from 24 to 72 inch, weighing 1,000 to 7,500 pounds per section, have been handled by this device a distance of 300 feet over sand so soft that a wheel tractor could not be used. The ability to turn in its own length allows more compact storing of the pipes.

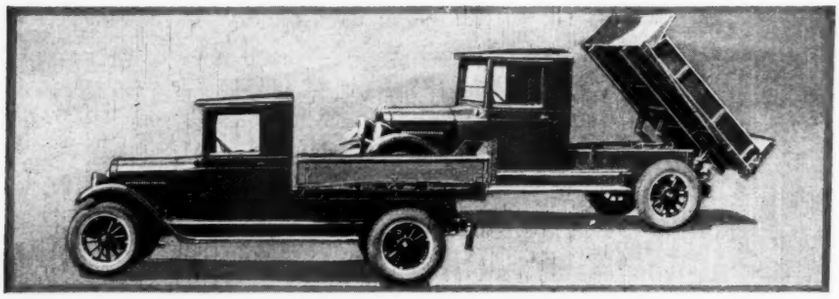


RIX HOIST.



BELLE CITY CRAWLER ROLLING PIPE.

file consists of a folding rack on which are 26 binders. When the doors of the cabinet are open, the file rack may be extended and the index on every binder is visible and readily accessible. The binders may be removed from the rack if desired. Each binder holds up to 100 tracings, ranging in size from 8 1-2 x 11 up to the maximum filing size of the cabinet. The maximum filing sizes range from 24 x 70 up to 48 x 70. Plans are fastened in the binders by the turn of a key. This file is of particular value when filing sets of prints. All tracings or prints relating to a job may be filed under one binder and indexed under one name.



WOOD TRUCK BODIES

NEW WOOD TRUCK BODIES

The Wood Hydraulic Hoist and Body Co., Detroit, Mich., has put out some new small-batch bodies for use on light trucks which enable the speedy and economical delivery of small loads. The Type J-1, all-purpose body, will be appreciated by contractors and those whose work is of a general nature. In addition to providing a 1 cubic yard capacity body for sand, gravel, etc., the sides may be removed and tailgate lowered, forming a smooth, clear platform, greatly increasing the range of usefulness of this body.

The Type M-4 body, which is the standard type of steel body for light trucks, has straight sides and square corners, with double-acting tailgate. The hoist used on these bodies dumps its load in from 4 to 6 seconds.

NEW COOK FIRE HYDRANT

A. D. Cook, Inc., Lawrenceburg, Ind., has brought out a new and sturdy fire hydrant which is especially designed to meet the specifications of the American Water Works Association and the National Board of Fire Underwriters. The thread of the operating nut is Acme standard; ten turns are required to open or close. The inside of the standpipe has an area 178 per cent greater than the valve area; the valve opening is 5¼ inches. All working parts are of bronze, and all parts are anti-freezing.

ARMCO PAVED CULVERT

The Armco Culvert Mfrs. Ass'n., Middletown, O., has announced the development of a paved culvert which, it is said, eliminates erosion of culverts due to sedimentary water and steep grades. This consists of a pipe with a specially prepared invert pavement of bituminous material, which not only protects the bottom of the pipe against wear, but also facilitates flow.

DUREX PORTABLE SAW RIG

C. I. Longenecker, Milwaukee, Wisc., has just put on the market a new portable saw rig, which, it is claimed, possesses advantage of easy handling, greater production, wider variety of uses, and safer operation. It is powered with an 8-horse power, 2-cylinder Le Roi gas engine, which is mounted under the table, where it is fully protected. This construction provides a close and compact outfit, requiring less floor space.

The table of the Durex tilts, which feature makes possible a great variety of uses. The saw travels in a straight line, providing the same cutting depth for the entire length of stroke, increasing the cutting capacity over ordinary rigs. The saws are fully protected. When ripping, the saw is automatically guarded at all times, while the cross-cut guard also gives protection. The cut-under frame allows the operator to stand in a natural and easy position.

PARKER COPPER FITTINGS AND COUPLINGS

The Parker Appliance Co., Cleveland, O., manufactures tube couplings and fittings for copper tube underground water service lines. All Parker appliances are cast from a special alloy having a low zinc and a high nickel content. It is claimed that with Parker fittings, copper services cost less than lead or brass pipe, and require less labor to install.

Parker tube coupling joints are made on the job, and may be made in the trench. The nut is slipped over the tube, the flaring tool inserted and struck sharply with a hammer. Drawing together then assures a perfectly tight and even joint.

MACKENZIE'S TRAFFIC SIGNS

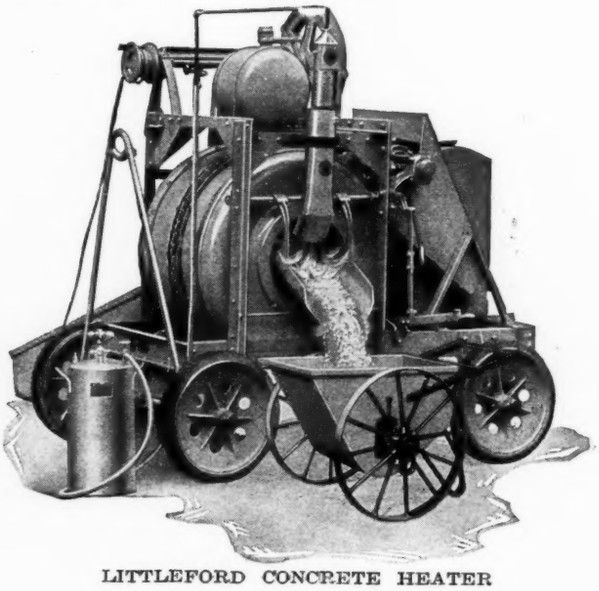
Duncan Mackenzie's Sons Co., Trenton, N. J., manufactures a wide range of traffic and direction signs suitable for a variety of purposes. Most of these are mounted on heavy cast iron bases. All signs are furnished with a screw connection so that they may be removed from the standard and taken in to be repainted, or another sign placed in position.

LITTLEFORD CONCRETE HEATERS

Littleford Bros., Cincinnati, O., has just produced a new line of kerosene burning concrete heaters suitable for mounting on any make or size of mixer. The line includes units for application on either tilting drum mixers or non-tilters.

With such a heater installed on a mixer, the manufacturer claims a mix can be discharged in zero weather at a temperature of 75 degrees F. No additional labor is required, as the man who operates the mixer operates the heater. The unit consists of a torch type oil burner of proper size, depending on the capacity of mixing drum, with fuel tank oil, oil hose, necessary fittings, elbow flame deflector, and a band for attaching to mixer. Installation is a very simple matter. A valve adjustment regulates the flame to any desired size. A windshield on the burner assures perfect operation under all weather conditions.

NEW COOK HYDRANT

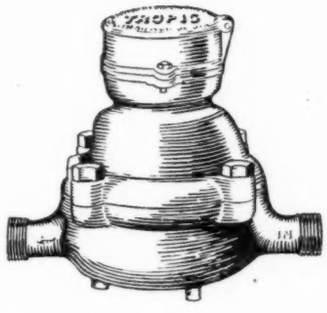


LITTLEFORD CONCRETE HEATER

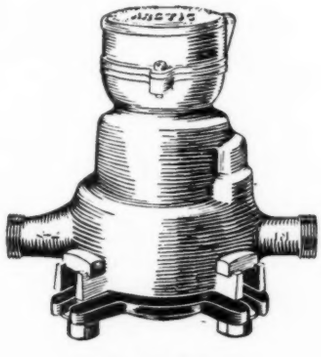
Our Research Laboratory is an important factor in making Better Meters!

AGAIN the initiative in manufacturing better water meters has been taken by the Pittsburgh Equitable Meter Company. Thousands of dollars have been invested in testing equipment and laboratories.

The entire department is at your disposal. Questions in connection with corrosion, water analysis, or electrolysis will be answered gladly and we will be pleased to assist you in working out any difficulties that may give you trouble.



TROPIC



ARCTIC

PITTSBURGH EQUITABLE METER COMPANY

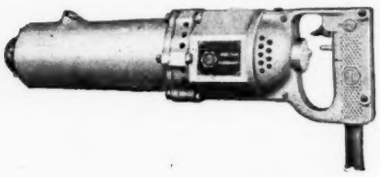
PITTSBURGH, PA.

BRANCH OFFICES

New York, New York.
Chicago, Illinois.
Dallas, Texas.
Los Angeles, Cal.
Tulsa, Oklahoma.
Seattle, Washington.
Columbia, S. Carolina.
Salt Lake City, Utah.
Kansas City, Missouri.

PORTABLE ELECTRIC HAMMER

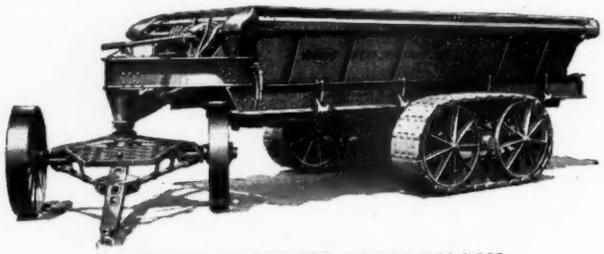
The Black & Decker Mfg. Co., Towson, Md., manufactures a portable electric hammer, which is valuable for many uses in construction work. The hammer strikes 2,300 blows per minute. The working mechanism operates in a bath of oil, and is sealed against dust and grit. It is equipped with a universal motor operating on direct or alternating current, from 25 to 60 cycles, and on voltages 10 per cent above or below normal.



BLACK & DECKER HAMMER

WESTERN CRAWLER DUMP WAGON

The Western Wheeled Scraper Co., Aurora, Ill., manufactures the Western Crawler dump wagon. This is a new type of wagon, of 7-yard capacity and equipped with Athey truss wheels. It is designed to operate economically behind a tractor of the crawler type, and to be loaded by elevating grader or power shovel. It does not mire in soft ground; it operates equally well over rough ground or sand. It can turn in any cut where a power shovel can revolve, or where an elevating grader can turn. Any dump over which the tractor can move is safe for this wagon. The sides are of 3-16-in. steel. There are two sets of bottom-dump doors, one in front of and the other behind the axle. Nothing obstructs the dumping. Ninety per cent of the load is carried on the truss wheels.



WESTERN CRAWLER DUMP WAGON

AUSTIN AUTOCRAT WORM DRIVEN ROLLER.

The Austin-Western Road Machinery Co., Chicago, Ill., has just announced a new 10-ton 4-cylinder motor roller, with modern stream line design and duplex worm drive. The design affords the operator an absolutely unobstructed view of both front and rear rolls, and shields the motor and its component parts from dust, the elements and petty thievery. The worm drive has the advantage of effecting an immediate reduction in speed, and is both silent in operation and free from undesirable vibration. Two gears are used, one above and the other beneath the single worm, an arrangement of especial advantage in a road roller, which works in reverse as much as in forward gear, and must therefore have the same traveling speeds forward and reverse.

The Austin Autocrat is equipped with an electric self-starter, but provision is also made for cranking the motor. While steering is ordinarily by a hand wheel, an efficient power steering mechanism is available. The regular transmission gives two speeds forward and reverse, with a high of 2.9 and a low of 1.6 miles per hour. A special 3-speed transmission gives a high speed of 4.5 miles an hour. the other speeds remaining as with the regular transmission.

WAMBLU TRAFFIC MARKERS.

The Wamblu Corporation, Rochester, N. Y., manufacture a large line of safety letters and markers for street and highway traffic control. These markers are made of a tightly woven fabric, which has been completely impregnated with long-oil paints. To the underside, an adhesive is vulcanized at a temperature of 400 degrees. The markers are backed together and it is only necessary to separate and apply on a clean dry surface. Automobile traffic can be directed over the marker immediately, and the heat of the sun completes the work of cementing the sign to the pavement. It is stated that these signs, which require no skilled labor for installation, have a usual life of 5 to 8 months, and are guaranteed for 3 months.

Wamblu markers are made in a variety of types and sizes. A late development is the curb marker, which saves the cost of painting signs on curbs and walks.

95-POUND PORTABLE PUMP

The Homelite Corporation, Port Chester, N. Y., manufactures a portable centrifugal pumping unit weighing 95 pounds which has a capacity of 7,500 gallons per hour. This unit, known as the Homelite Portable Centrifugal Pump, consists of a high-efficiency centrifugal pump with bronze open-type impeller direct connected to a 1½-h.p. single-cylinder air-cooled motor operating on gasoline or kerosene. Pump and engine are mounted on the same base, which also acts as a fuel tank, holding one gallon—sufficient to operate the engine for four or five hours. The single shaft runs on ball bearings. Pump suction and discharge are 2 inches in diameter. The lift of the pump is 20 feet; head, 45 feet. It will handle muddy, gritty water, oils, chemicals or anything that will pass through the foot-valve strainer. The engine being air cooled, the outfit is independent of cooling water supply and can be used even in the lowest temperatures. Ignition is supplied by a Bosch high tension damp-proof magneto. Portability is due not only to the low weight of 95 pounds, but also to the fact that the unit can be set anywhere without need for foundations, skids or blocking. Ingeniously conceived spring feet result in stability and absorption of vibration.

PARKER TRENCH PUMPS

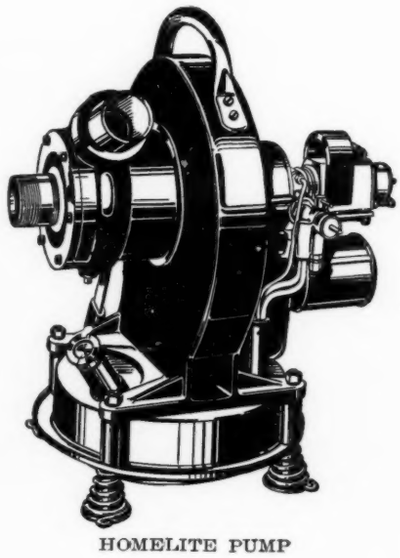
A. A. Parker, Waterford, N. Y., has added to his line of pumps, the Little Giant Trench Pump. This outfit is constructed entirely of metal, and is claimed to be practically indestructible. The pump is powered with a 2-cylinder roller bearing engine of automobile type, driving through a worm-geared speed-reducing pump jack, operating in an oil-tight case. This outfit, which has bronze bushings and ball bearings throughout, is especially designed for use in trench and foundation work.

LEBLOND-SCHACT "ROADMAKER"

The LeBlond-Schacht Truck Co., Cincinnati, Ohio, manufactures the Schacht "Roadmaker," which is a 2-yard, 2-batch truck with a maximum carrying capacity of 3½ tons. It has a wheelbase of 132 inches and is equipped with an 8-ft. dump body, 6 inches wider at the rear, permitting the contents of the load to slide out easily without any manual effort when the body is elevated.

The Roadmaker is equipped with 36x6 pneumatic tires (duals in the rear) mounted on Budd disc wheels, which provide increased traction when operating in mud. The number of days that the average dump truck is compelled to be idle, due to unfavorable weather and road conditions, is reduced to a minimum with this equipment, which can operate efficiently even in soft mud.

The maximum governed speed of the Roadmaker is thirty miles per hour. Complete equipment includes St. Paul underbody hoist, 2-yard steel body with side boards and division gate, Crescent convertible cab and electric lights and starter.



HOMELITE PUMP

MUNICIPAL AND OTHER PUBLIC REPORTS

(*Continued from page 38*)

best known. The Great Salt Lake Basin includes the northern part of Utah, a small part of eastern Nevada, the southeast corner of Idaho, and the southwest corner of Wyoming. It extends about 180 miles east and west and about 150 miles north and south and has an area of 27,000 square miles. Great Salt Lake, which is a shallow remnant of the much larger prehistoric Lake Bonneville, rests on the surface of a broad plain and has an average depth of about 15 feet. There are many similar lakes in the Great Basin, although Great Salt Lake is by far the largest. A few of the larger ones are Goose Lake, in California and Oregon; Mono Lake, Owens Lake, and Salton Sea, in California; Malheur, Summer, Silver, and Abert Lakes, in Oregon; Carson and Walker Lakes, in Nevada; and Sevier Lake, in Utah. There is a total water surface in all the lakes of the Great Basin of several thousand square miles. The scores of rivers that feed these lakes are, of course, of great local importance because of their use for irrigation and in several localities for water power.

This report is for the year ending Sept. 30, 1923.

TRADE PUBLICATIONS

Floodlighting, Including Searchlight and Airport Lighting. The General Electric Co., Schenectady, N. Y., Ill., 24 pp.

Describes the late accomplishments in flood lighting and reviews the principal types of projectors.

Air-Made Wells. Five bulletins describing the methods of use and advantages of the Air-Made Well Co., Oklahoma City, Okla., which methods have proven valuable in bringing back into production a number of clogged or dry wells.

Armco Drainage Structures. Armco Culvert Mfrs. Assn., Middletown, O. A 16-page illustrated bulletin "Applying Culvert Simplicity to Highway Bridge Requirements"; a 24-page illustrated bulletin "Planning Municipal Drainage Today and To-morrow"; a 20-page bulletin "Basing Confidence in Culvert Strength on Engineering Facts"; a 16-page bulletin "Increasing the Efficiency of Road-bed Drainage."

Turbines for Mechanical Drive. Westinghouse Electric and Manufacturing Co., Pittsburgh.

Leaflet 3907-C describes turbines for mechanical drive in capacities of 5 to 750 brake horse power. These are admirably suited for driving circulating pumps, centrifugal boiler feed pumps, blowers and other rotary apparatus either directly or through the medium of reduction gears. The leaflet contains a number of illustrations together with descriptive information of the turbines.

Truscon Data Book. Truscon Steel Co. 24 pp. ill. The contents include description of the Truscon improved open truss type steel joist, wood and concrete floor construction, safe loads, details, and specifications. Free upon application.

A B C of Hydrogen Ion Control. La Motte Chemical Products Co., Baltimore, Md. 80 pp. ill. A brief and simple treatise on the theory and practice of making hydrogen ion measurements colorimetrically. These are discussed in considerable detail, but in such simple language as to be understandable to non-technical men also. Free upon application.

INDUSTRIAL NOTES

Burns & McDonnell Engrg. Co., Kansas City, Mo., has just published an attractive booklet "The Purification of Water," which gives an interesting account of the establishment of the firm and furnishes material of interest and value regarding water supply and treatment. Copies will be sent free upon request.

The Grasselli Chemical Co., Cleveland, O., are using zinc chloride as a preservative for highway guard rails and posts. It is claimed to have the following advantages: First, guard posts and rails treated with zinc chloride can be painted white, giving good visibility at night, while posts and rails treated with oily preservatives soon turn dark, thus reducing visibility; second, zinc chloride treatment costs considerably less than other methods of preserving wood; third, zinc chloride increases the life; fourth, zinc chloride greatly reduces the inflammability of wood.

COOK GETS FIFTEEN HUGS

The Hug Arkansas Truck Company, distributor for Hug Roadbuilding equipment in the State of Arkansas, has sold fifteen Hug Roadbuilder trucks to M. D. L. Cook, of Little Rock, Arkansas. These trucks are the Model 80 Hug Roadbuilder chassis, equipped with three-yard power hoist body, equipped with partition gates adapting the body for double batch hauling. Recently The Hug Company reported the sale of fifty roadbuilder's models to the General Materials Company, of St. Louis, Missouri, and twenty to the Cleveland Paving Company. of Cleveland, Ohio.

LESSMAN LOADER CO.

The Lessman Loader Co., Des Moines, Ia., has acquired all manufacturing and selling rights for the Lessman Loader, which operates with the Fordson tractor.

BAY CITY DREDGE WORKS

The Bay City Dredge Works, Bay City, Mich., have just completed a special truck mounted crane for the Public Works Department of Milwaukee, Wis. This machine is essentially the upper framework and assembly of the standard Bay City tractor shovel, with the crawler mounting, tractor and car body eliminated. It is mounted on a Sterling 5-ton truck. The equipment was designed for handling and placing cast-iron electric light poles in connection with a white way system being installed.

THAYER WITH VIBROLITHIC

The American Vibrolithic Corp., Des Moines, Iowa, announces the appointment of M. Russell Thayer as consulting engineer, with headquarters in Des Moines. Mr. Thayer will operate in all territories under the direction of the corporation.

SILVER WITH COX ADVERTISING AGENCY

Ralph R. Silver, for the past twelve years advertising manager of the American Cast Iron Pipe Company, is now associated with the Cox Advertising Agency, Birmingham, Alabama, and under plans of reorganization will acquire a substantial interest in this well known advertising firm.

YOUNG RADIATOR CO.

John J. Hilt, formerly associated with F. M. Young in the Racine Radiator Co., has been appointed sales manager of the Young Radiator Co., Racine, Wisc. Three other former associates of Mr. Young have joined the company. D. A. Hisey has become superintendent in charge of production; W. C. Klespe is engineer in charge of design; and, Christ R. Trumm has charge of the tool room and machine production.

GENERAL ELECTRIC APPOINTMENTS

W. M. Sterns has been transferred from the central station department of the General Electric Company to the general commercial department, and has been appointed manager of special contracts. He will also act as an assistant to vice president J. G. Barry.

A. D. Cameron has been appointed manager of the street lighting and supply division of the central station department, and there has been set up in the same department a holding company division with W. P. White as manager.

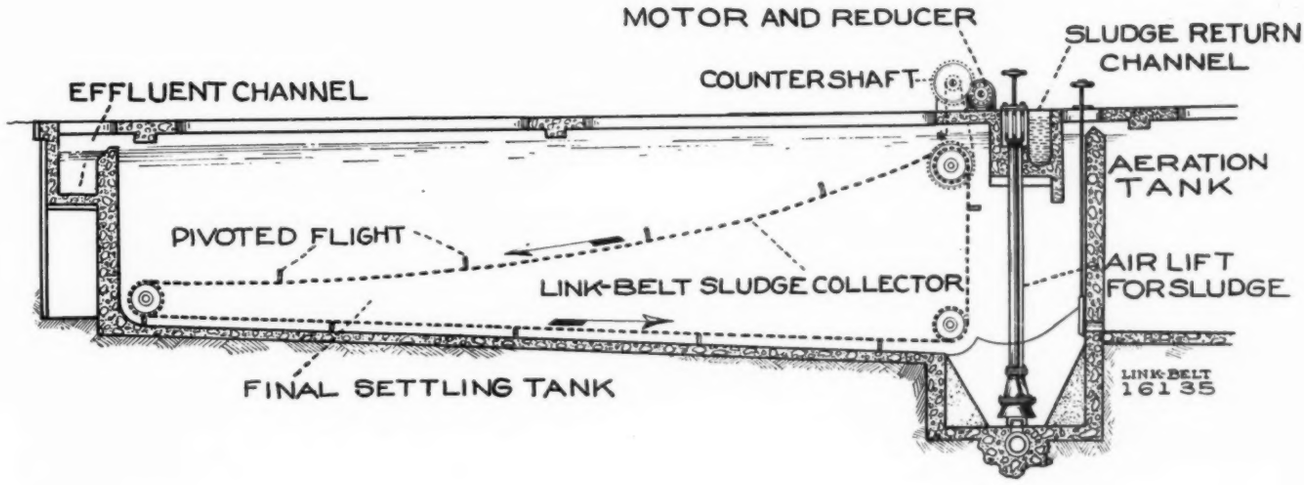
F. H. Winkley has been appointed manager of sales of the street lighting section of the street lighting and supply division, succeeding Mr. Cameron.

LINCOLN ELECTRIC REPRESENTATIVE

The Lincoln Electric Company, Cleveland, Ohio, announces the transfer of E. F. Hoff from Cleveland to New York, where he will be in charge of Welder Service under the direction of G. N. Bull, district manager.

The Lincoln Electric Company, manufacturer of "Linc-Weld" Motors and "Stable-Arc" Welders, announces the appointment of E. A. Thornwell of Atlanta, Georgia, as its representative for Georgia and Eastern Tennessee. Mr. Thornwell has been actively associated with the electric industry in Atlanta, Georgia, and Pittsburgh, Pennsylvania, since his graduation in 1904 from Clemson College, South Carolina. John Van Horn, factory engineer for the Lincoln Electric Company, also has been attached to the Atlanta office.

Quick and Total Removal of the Settled Sludge



THE quick and total removal of the settled sludge, was the principal reason for the selection of Link-Belt Sludge Collectors for the final settling tanks for the activated sludge plant at Charlotte, N. C., by Wm. M. Piatt, Consulting Engineer.

The wood flights of the Link-Belt Sludge Collector automatically adapt themselves to the floor and sweep all of the sludge into the hopper at the influent end.

After a few months of operation the bottom of the tank is polished smooth by these flights, and after that the wear is taken by the steel tracks.

Although the speed of the collectors is slow (only 2 feet per minute), none of the settled sludge stays in the tank longer than thirty minutes.

The heavy chain gives years of satisfactory service. One installation of Link-Belt Sludge Collectors, has been in operation over five years at Gastonia, N. C., without a cent having been spent for repairs during the entire period.

Our nearest office will be glad to furnish you with complete data.

UTILITIES CAPITAL CO.

The Utilities Capital Co., Inc., New York, has been formed for the purpose of financing, operating and managing public utility properties, making valuations, surveys and investigations, and doing other work in connection with public utility operations. J. J. Cagney is president.

CLIMAX ENGINEERING CO'S NEW VICE-PRESIDENT

E. B. Mallory, formerly of the Westinghouse Co., has been elected vice-president and member of the Board of Directors of the Climax Engineering Company, Clinton, Ia.

WILDER-STRONG ROAD SIGNS

The Wilder-Strong Implement Co., Monroe, Mich., are now handling their own road sign sales work, which was formerly managed by H. J. Andrews, Fort Wayne, Ind.

INDIANA TRUCKS FOR PALISADES PARK

The Indiana Truck Corp., Marion, Ind., have just delivered 9 Model 41 motor trucks equipped with 5-yard dump bodies to the Palisades Interstate Park Commission, which now operate a fleet of 45 Indiana trucks.

BELLE CITY MFG. CO. MAKES FOREIGN SHIPMENTS

The Belle City Mfg. Co. of Racine, Wis., who have had a large demand for their crawlers for plowing and other agricultural uses as well as for construction and road work, have received an order for several more carloads of this equipment for foreign delivery.

TACOMA ELECTROCHEMICAL CO.

The Tacoma Electrochemical Co., all the capital stock of which is held by the Pennsylvania Salt Mfg. Co., Philadelphia, has been formed, and will construct a plant at Tacoma for the manufacture of liquid chlorine and caustic soda, and later, other items.

M'NALL ADVERTISING MANAGER FOR SPEEDER MACHINERY CORP.

Edgar McNall, for eight years connected with the advertising departments of Cedar Rapids newspaper, has been appointed advertising manager of the Speeder Machinery Corporation, Cedar Rapids, Iowa, manufacturer of Speeder shovels, pull-shovels, skimmers, cranes, draglines and backfillers.

CHAIN BELT PURCHASES ATLAS ENGINEERING CO.

The Chain Belt Co., Milwaukee, Wisc., has purchased the plaster and mortar mixer business of the Atlas Engineering Co., and a complete line of mortar and plaster mixers will be added to the Rex Line of concrete mixers. The Chain Belt Co., which was organized in 1891 by C. W. Levalley, operates two plants in Milwaukee and one in Cleveland. Branch offices are maintained in 16 principal cities.

Four other companies are affiliated with the Chain Belt Company—the Federal Malleable Company, Sivyer Steel Casting Company, Interstate Drop Forge Company of Milwaukee, and the Nugent Steel Casting Company of Chicago. The Stearns Conveyer Co., Cleveland, O., manufacturer of belt conveyors, was purchased about a year ago.

BELLE CITY MANUFACTURING CO.

The Belle City Manufacturing Company of Racine, Wisconsin, manufacturer of individual and neighborhood threshing outfits and crawler attachments for Fordson Tractors, has recently introduced new capital into its company which enables it to increase its production and bring out several new lines of equipment which have been in development for some time. New officers were elected on September 13, as follows: H. A. Reed, president and general manager; W. J. Tostevin, vice president; G. A. Nelson, secretary-treasurer; H. A. Schultz, asst. secy. and asst. treas.

BYERS PURCHASES MASSILLON POWER SHOVEL CO.

The Byers Machine Co., Ravenna, O., has purchased the Massillon Power Shovel Co. and will continue the manufacture and distribution of Massillon Shovels along with the Byers Bear Cat line. The purchase will provide the Byers Machine Co. with a complete line of shovels and cranes from ½ to 1¼-yard capacity. It will also allow important economies in manufacturing and selling. The present manufacturing plants of both companies will be continued, Massillon Shovels being manufactured as before at the Massillon, O., plant under the direction of E. H. Birney, president of the Massillon Power Shovel Co.

LITTLEFORD SHIPS LARGE ORDER

Littleford Bros. of Cincinnati, Ohio, recently shipped the last carload of what from all information available is the largest single order ever placed for tar and asphalt heaters. The order was received from the State Highway Department of Texas and called for a lot of 50 Trail-O-Heaters, each having a capacity of 300 gallons, and each equipped with hand spraying attachment. The Texas State Highway Department will use these Trail-O-Heaters for maintenance of roads throughout the State. The transaction was handled through the Browning-Ferris Machinery Co., Littleford distributors for the state of Texas.

DE-IRONING SOUTH DAKOTA ROADS

The South Dakota State College, in collaboration with the Minneapolis Service Shop of the General Electric Company, recently mounted 12 magnet coils on a magnet suspended under a state highway truck for use in picking up nails and tacks from the highways of the state. Inasmuch as this outfit will be used occasionally in wet weather, the coils were constructed so as to withstand moisture. On a trial run of three miles over a gravel highway just south of Brookings, the outfit picked up 36 pounds of nails, tacks, screws, bolts, and other iron particles.

The truck travels at 10 miles an hour and covers an eight-foot strip of roadway on one trip. The magnet has a length of seven feet and also draws pieces of metal for a distance of about six inches from each end. The position of the magnet under the truck is adjustable; it is usually operated at a height of four inches above the ground. Power is supplied by a gasoline engine-driven generator mounted on the truck.

AIRWAY BEACONS INSTALLED BY DEPARTMENT OF COMMERCE.

One hundred additional new airway beacons have been installed at intervals of ten miles along the regular transcontinental airway between Chicago and St. Paul, and also along the New York and Atlanta airway.

These beacons, furnished by the General Electric Company, are the 24-inch revolving type, which has now become the standard for the airways maintained by the Department of Commerce. They have a beam candlepower of 2,000,000 when used with a 1,000-watt, 115-volt incandescent lamp. The beacons are equipped with an automatic lamp changer, a device which, upon the failure of one lamp, automatically puts a similar lamp in place; also with a flashing mechanism which is used to produce the characteristic flashing signals sent out by the on-course lights on the airways.

TOWNSEND JOINS INDIANA TRUCK.

Ray F. Townsend has been appointed assistant to the president of the Indiana Truck Corporation, Marion, Ind. Mr. Townsend has been engaged for many years in sales and distribution work in the automotive industry. He will work with the branch and distributor organization.

J. D. ADAMS CO. ENLARGES PLANT.

A new building at the plant of J. D. Adams & Co., Indianapolis, Ind., is now in course of construction. With this building, the plant is now 84 per cent. larger in area and facilities than the new plant built four years ago to replace the one destroyed by fire. Another building just completed provides an increase of 125 per cent. in office space. The J. D. Adams & Co. plant is now one of the most modern in the road machine industry and is said to be the largest in the world devoted to the manufacture of road graders.

The company states that the new addition is to permit expansion in all deparements to take care of its steadily increasing busines, but more particularly to accommodate new machinery required by the machine work now put on Adams adjustable leaning wheel graders. During the past two years practically every working joint in Adams graders has been redesigned and now is machine finished to a very close fit in order to prevent lost motion and to prolong life.